# Agilent 1200 Series Evaporative Light Scattering Detector


## Service Manual

Agilent Technologies

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**CAUTION**

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# In This Guide...

This manual is designed to describe the installation; operation, maintenance and basic troubleshooting of the G4218A Agilent Evaporative Light Scattering Detector. It includes:

### 1 Introduction

### 2 Site Requirements and Specifications

Site requirements and specifications of the Agilent 1200 Series Evaporative Light Scattering Detector

### 3 Installing the Detector

Installation of the detector

### 4 Using the System

This chapter describes how to operate the Low Temperature Evaporative Light Scattering Detector. It includes information about starting the unit on a routine basis, collecting data and shutting down the unit.

### 5 Optimizing Performance

This chapter shows how to optimize the detector to achieve best results

### 6 Troubleshooting and Diagnostics

This chapter describes a series of activities that should be performed on a periodic basis to ensure maximum performance. In addition, this chapter includes a protocol that can be used to determine the cause of problems that are observed with the instrument.

### 7 Maintenance

Introduction to maintenance and repair, instructions on simple, routine repair procedures

### 8 Repairs

Instructions on more extensive repairs requiring exchange of internal parts

### 9 Parts for Repair

Detailed illustrations and lists for identification of parts and materials for repair

### 10 Identifying Cables

Information about cables

### Appendix A The Control Panel

This chapter describes the role of the various controls and displays on the detector.

### Appendix B Appendix

This chapter contains safety information.

# Contents

# 1
# Introduction

# The Low Temperature Evaporative Light Scattering Detector

The Agilent 1200 Series Evaporative Light Scattering Detector (Figure 1) is designed to detect compounds in the eluent from high performance liquid chromatography (HPLC), micro-HPLC, gel permeation chromatography (GPC) or counter current chromatography (CCC). It is capable of monitoring eluent flow rates from 5 µl/min to 5 ml/min. Evaporative light scattering detection is a universal technique which can detect any non-volatile analyte. Detection does not depend on the absorbtion of radiation and is not affected by the absorbtion characteristics of the solvent; thus solvents which absorb UV radiation can be used.


**Figure 1** The Agilent 1200 Series Evaporative Light Scattering Detector

The detector is controlled via the keypad and digital display on the front panel. Alternatively, the system can be controlled by an external computer using the RS-232 port. The output can be sent to a recorder or data station. The detector includes a nebulizer, evaporation tube and detector head. The evaporation tube is located in an oven to assist in the evaporation of the solvent.

# Principle of Operation

There are three steps in the operation of the detector:

1 nebulization of the eluent,

2 evaporation of the solvent and

3 detection of the compound(s) of interest (Figure 2).


**Figure 2** Schematic Diagram of an Evaporative Light Scattering Detector

Nebulization involves the conversion of the eluent into a fine mist. The mist is passed through an evaporator to vaporize solvent. In the detector unit, the mist is irradiated by a light source and scattered light is measured by a photomultiplier (PM). The degree of light scattering is related to the concentration of the compound of interest in the sample. A cross sectional view of the system is presented in Figure 3.

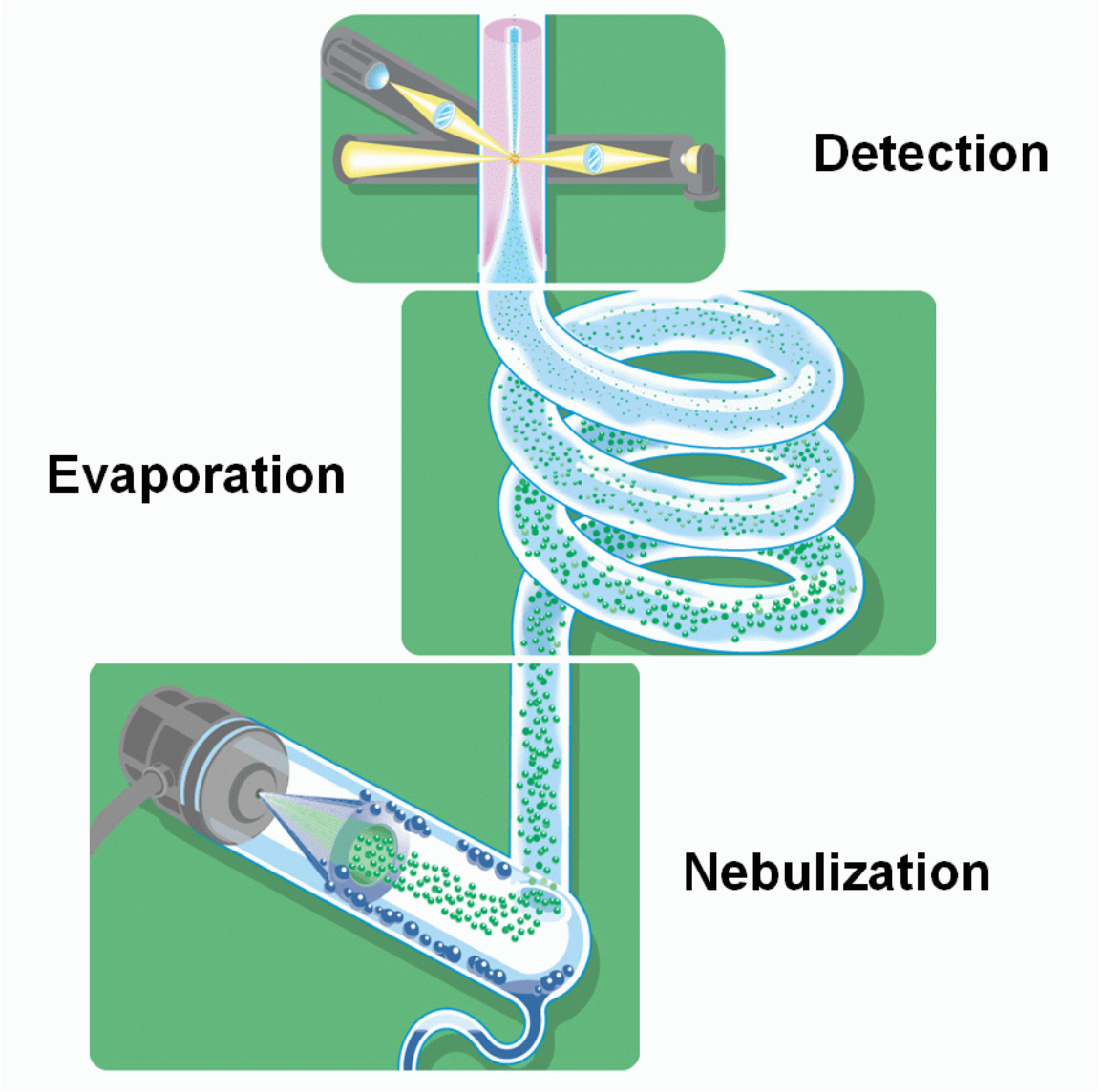



**Figure 3** Schematic display of principle measurement steps in the ELSD of the Detector

## Nebulization

The eluent from the chromatograph is nebulized by the inlet gas (typically nitrogen). At the outlet of the nebulizer, the aerosol travels through a chamber. Large droplets in the aerosol go to a siphon while the fine mist moves to the evaporation tube. The overall design of the nebulizer is shown in Figure 4 and the nebulization chamber is shown in Figure 5.

Four different nebulizers are available for optimizing the performance of the detector at different HPLC flow rates (see Table 13). The user should select the nebulizer to best match the flow rate that will be used with the separation when the detector is ordered (the optimal range for each nebulizer is indicated in Table 13). Additional nebulizers are available from Agilent Technologies and can be easily installed, see “Installing the Nebulizer and Nebulization Chamber Assembly” on page 45.

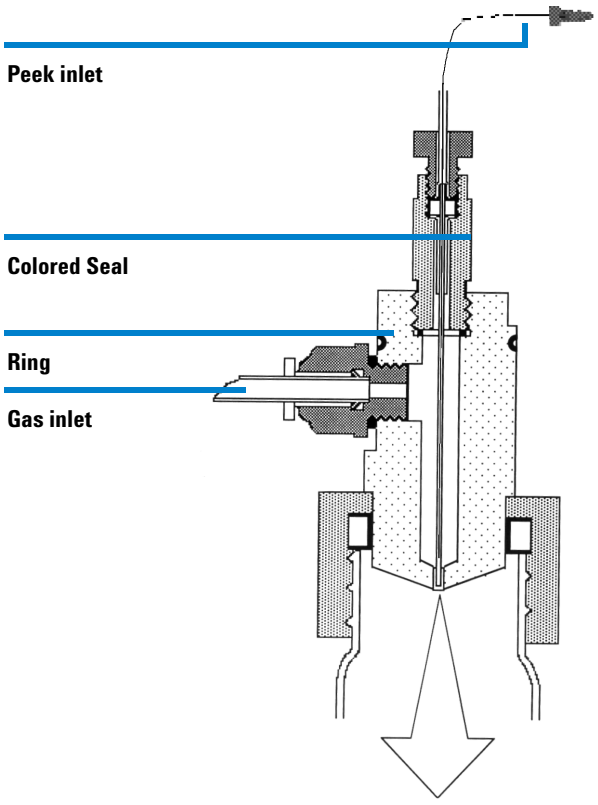



**Figure 4** Design of the Nebulizer

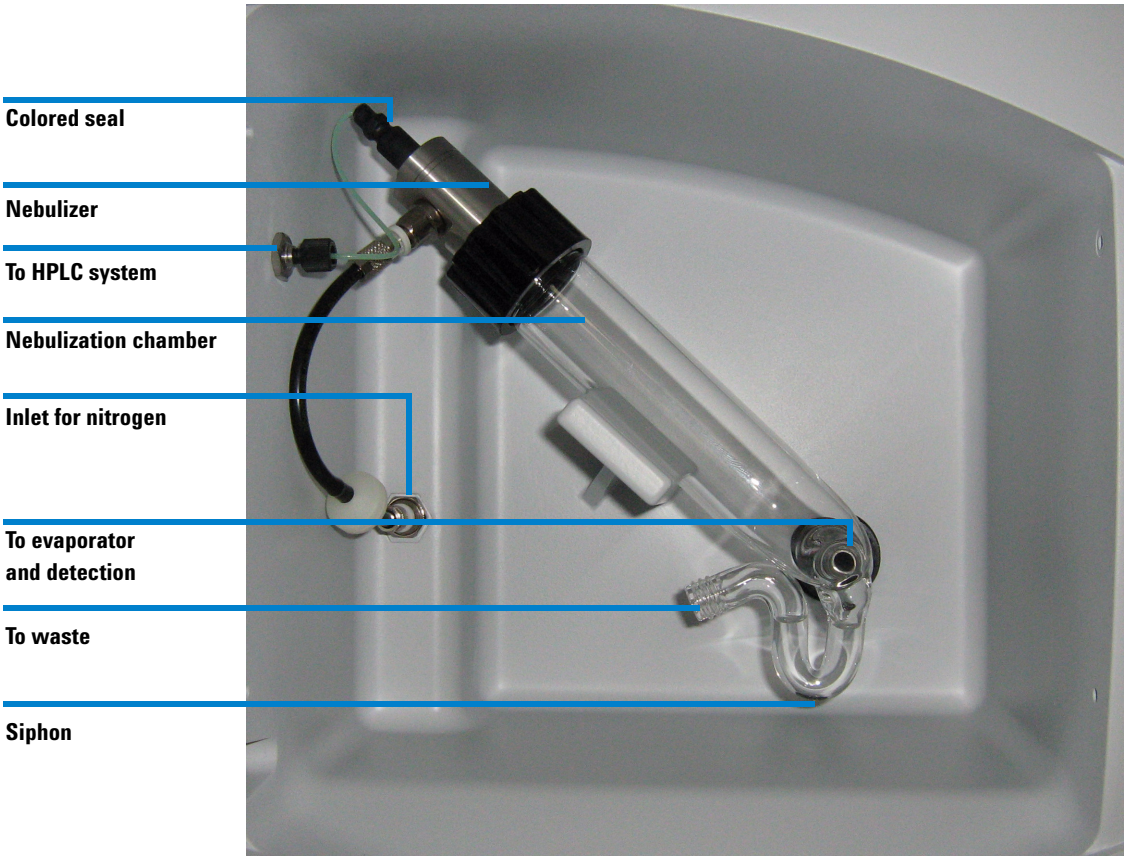



**Figure 5** The Nebulizer

## Evaporation of the Solvent

A heated tube is used to evaporate the solvent. The exit of the heated tube leads directly into the detector cell.

In liquid chromatography, water and organic solvents with low boiling points are typically employed (e.g. methanol, acetonitrile). A typical mobile phase for a reverse phase separation using evaporative light scattering detection might be methanol/water (60/40) while a typical mobile phase for normal phase separation might be hexane.

If acids, bases and salts are used to modify mobile phase to provide the desired separation, they should be able to be readily evaporated, sublimed or decomposed into gases in the evaporation tube. Mobile phase modifiers that are commonly used when an evaporative light scattering detector is employed include $NH_4OH$, $(C2H_5)_3N$, $NH_4OAc$, HCOOH, $CH_3COOH$, $CF_3COOH$ and $HNO_3$.

## Detection

The carrier gas transports the microparticles from the heating tube into the detection chamber (Figure 6).

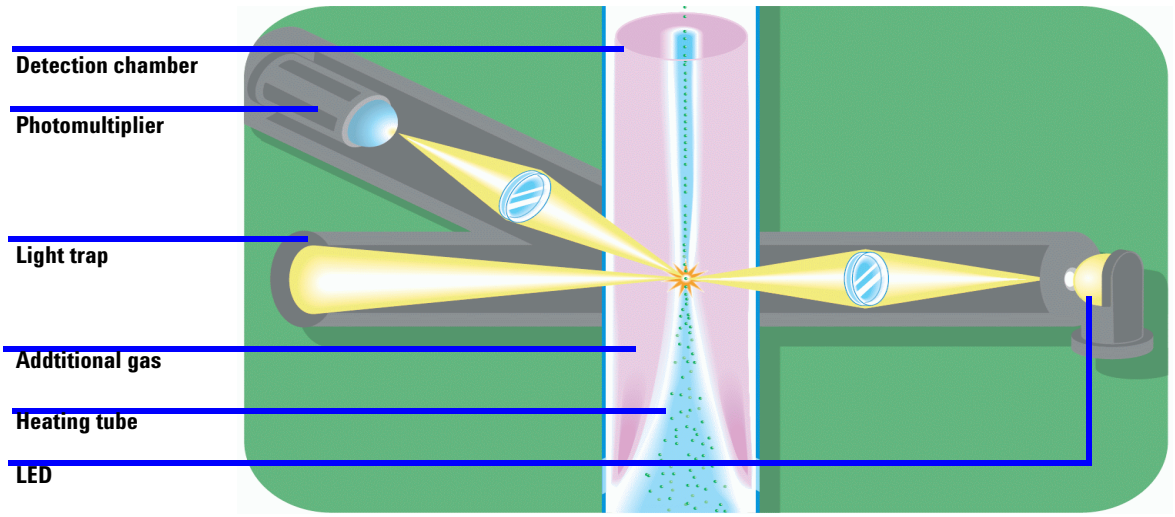



**Figure 6** The Detection Chamber

The detector chamber contains a light emitting diode (LED) and a photomultiplier that is positioned at an angle of $120^{o}$ with respect to the light beam (Figure 6). When the carrier gas contains microparticles, the light is scattered and is detected by the photomultiplier.

The intensity of the scattered light is a function of the mass of the scattering particles and generally follows an exponential relationship, which is shown in Equation 1.

$$\mathbf{I = k\ m^{b}} \qquad \textbf{(1)}$$

where:

**I** is the intensity of light

**m** is the mass of the scattering particles

**k** and **b** are constants

A plot of log I versus log m provides a linear response. The values of the constants (k and b) depend on a variety of experimental conditions (e.g. the temperature and the nature of the mobile phase).

A gas inlet before the detector chamber provides a concentric shield for the carrier gas. This serves to eliminate diffusion of the carrier gas and eliminates contamination of the detector cell.

# 2
# Site Requirements and Specifications

# Site Requirements

A suitable environment is important to ensure optimum performance of the Agilent 1200 Series detector.

## Power Considerations

The detector is configured for either 100 V AC / 50-60 Hz, 115 V AC / 60 Hz or 230 V AC / 50 Hz input power depending on the country to which it is shipped. Ensure that the voltage value indicated on the power connector on the rear panel corresponds to the line voltage in your facility.

The detector requires G4218-64000 230 V, 1.7 A, 400 W, 50 Hz, G4218-6410 115 V, 1.8 A, 210 W, 60 Hz, G4218-64020 100 V, 2.1 A, 210 W, 50/60 Hz. Check that the power lines can provide sufficient current.

The detector must be connected to a properly grounded three prong plug to ensure proper operation of the system. If a two prong outlet is used, make sure that the ground wire is used to ground the instrument. It is recommended that all components of the HPLC system are connected to a common ground.

The detector should not be connected to an electrical line which also serves units with a large power drain or which may be subject to power surges. Such units include refrigerators, ovens, centrifuges and fume hoods.

**WARNING**

***Incorrect line voltage at the instrument***

**Shock hazard or damage of your instrumentation can result, if the devices are connected to a line voltage higher than specified.**

⇒ Connect your instrument to the specified line voltage.

## Gas Considerations

A supply of clean, filtered, oil free inert clean gas (typically nitrogen) is required to operate the detector. The gas supply needs to be free of particles, as particles will create background noise in the chromatograms. In case of

such noise for example for newly installed gas lines, flush the gas lines for sufficient time (might take days) and consider additional filters. Pure gas is not required as the gas is only used as a carrier for the solid sample particles.

**CAUTION**

*Damage of pressure sensor*

Pressures above 4.5 bar (67 psi) can damage the pressure sensor of the detector. The gas consumption for the large nebulizer is 4 l/min and 3 l/min for all other nebulizers. The target pressure for most applications is 3.5 bar (51 psi).

=> Do not switch on the gas flow suddenly, as this may cause the exceeding of maximum pressure. The use of a separate pressure regulator is highly recommended. A filter (0.01 µm) and manometer (part number G4218-60100) is available as an option. Replacement filter cartridges are available as part number G4218-40150.

## Power Cords

Your detector is delivered with a power cord which matches the wall socket of your particular country or region. The plug on the power cord which connects to the rear of the instrument is identical for all types of power cord.

**WARNING**

***Electric Shock***

**The absence of ground connection and the use of an unspecified power cord can lead to electric shock or short circuit.**

=> Never operate your instrumentation from a power outlet that has no ground connection.

=> Never use a power cord other than the power cord designed for your region

**WARNING**

***Use of unsupplied cables***

**The use of cables which haven't been supplied by Agilent Technologies can lead to damage of the electronic components or personal injury.**

=> Never use cables other than the ones supplied by Agilent Technologies to ensure proper functionality and compliance with safety or EMC regulations.

## Exhaust venting and drain requirements

The exhaust from the detector must be directed into a fume hood or exhaust vent. If a vacuum is used, it should be moderate so as to avoid turbulence in the glass cell siphon. The potentially hazardous exhaust of evaporated solvent and sample must not be allowed to enter the laboratory atmosphere and any appropriate accessory like solvent filters should be disposed according to local environmental requirements.

The drain tube must be directed to a suitable solvent. The user is responsible for decontamination or recycling of any residue, regarding to local environmental requirements.

**CAUTION**

*Toxic and hazardous vapors*

Exhausts could cause personal injury or laboratory pollution.

=> Make sure the instrument is installed and the exhaust is vented according to local regulatory authorities for health and safety requirements.

## Location of the Detector in the Laboratory

All components of the system (e.g. HPLC pumps, detector) should be located on a robust table. The detector should be placed in an area that is free from drafts or significant temperature changes. Do not place it near air conditioning vents, windows, ovens, etc.

When placing the detector in the laboratory, access to the power to disconnect the device (the appliance coupler or the mains plug) must be kept accessible at all time.

The detector should be placed close to the outlet of the column to minimize extra-column band broadening which will reduce the resolution of the chromatogram.

## Environment

This instrument has been designed for following conditions:

- Use inside buildings
- Altitude up to 2000 meters
- Ambient temperature from 5°C to 40°C
- Maximum humidity of 80% for temperatures under 31°C, with linear decrease to 50% at 40°C
- Maximum variations for main power voltage:  10% from nominal voltage.
- Transitory overvoltage of class II
- Pollution degree: 2

# Specifications

**Table 1** Specifications ELSD

| | |
|---|---|
| **Detection** | High Sensitivity Photomultiplier |
| **Light Source** | Selected High Efficiency Blue LED |
| **Temperature Range** | Ambient to 100 °C |
| **Gas Flow Control** | Manual and computer controlled nebulization gas flow and auxiliary gas flow. |
| **Gas Consumption** | Less than 4 l/min for the Large Flow Nebulizer, less than 3 l/min for all other nebulizers. |
| **Gas pressure** | 3.5 bar (51 psi) typical, min. 3 bar (44 psi) to max. 4.5 bar (67 psi) |
| **Eluent Flow Rate** | Micro Flow Nebulizer: 5 µl/min to 50 µl/min |
| | Semi Micro Flow Nebulizer: 40 µl/min to 1 ml/min |
| | Standard Flow Nebulizer: 500 µl/min to 2 ml/min |
| | Large Flow Nebulizer: 1.5 to 5 ml/min |
| | Rapid Resolution Nebulizer: 0.2 to 1.4 ml/min |
| **Instrument Control** | Microprocessor with stand alone manual keypad or Windows based PC control (see specifications for your instrument control software) |
| **Operating Parameters Control** | Liquid Crystal Digital Panel |
| **Signal Drift*** | Less than 1 mV/h |
| **Signal Noise*** | < +/- 1 mV |
| **Signal Output** | 0-1 V (Analog) |
| | RS-232 (Digital) |
| **Inputs** | Remote Autozero (Contact Closure or TTL Signal) |
| | Remote Powerdown Mode (Contact Closure or TTL Signal) |

**Table 1** Specifications ELSD

| | |
|---|---|
| **Power Down Mode** | General, Standby, Cleaning |
| **Zero Control** | Manual Auto Zero and Remote Auto Zero |
| **Interface** | RS-232 I/O Serial Output |
| **Power G4218-64000** | 230 V, 1.7 A, 400 W, 50 Hz |
| **Power G4218-64010** | 115 V, 1.8 A, 210 W, 60 Hz |
| **Power G4218-64020** | 100 V, 2.1 A, 210 W, 50/60 Hz |
| **Dimensions** | 250 mm (10") W x 450 mm (18") H x 550mm (22") D |
| **Weight** | 18.5 kg (40 lb.) |

* Conditions for drift and noise:
Eluent Flow: 0 ml/min
Evaporator Temperature: 50 °C
Nebulizer Gas: Nitrogen, pressure 3.5 bar
Gain: 12
Noise: measured as mean value for 10 segments of 1 minute. For each segment the difference of the highest minus the lowest peak is calculated and divided by 2.

# 3
# Installing the Detector



This chapter describes how the laboratory should be prepared to optimize the performance of the Agilent 1200 Series Evaporative Light Scattering Detector and indicates how the unit is interfaced to other devices such as the column and the data recording device. When you have successfully installed the unit, refer to Chapter 4 for start-up procedures.

# Lifting and Carrying the System

**CAUTION**

*Safe transport*

Instrument is fragile and heavy

=> To ensure safe transport and avoid bodily injury, make sure that the system is lifted by two persons.

Once the system is unpacked, ensure that no cables or tubing are connected when you carry the instrument. The system should be lifted by the bottom (e.g. place your hands under the instrument). Two persons are needed to ensure easy transport and avoid bodily injury (Figure 7).


**Figure 7** Carrying the System

# Unpacking the System

**CAUTION**

*"Defective on arrival" problems*

If there are signs of damage, please do not attempt to install the module. Inspection by Agilent is required to evaluate if the instrument is in good condition or damaged.

=> Notify your Agilent sales and service office about the damage

=> An Agilent service representative will inspect the instrument at your site and initiate appropriate actions.

=> It is recommended that the shipping carton be retained as it can be used if it should become necessary to transport the system.

**Table 2** Components Shipped with the Agilent 1200 Series Evaporative Light Scattering Detector

| Quantity | Part Number | Description |
|---|---|---|
| 1 | G4218-20000 | Standard Flow Nebulizer |
| 1 | G4218-40000 | Nebulization chamber, glass |
| 1 | G4218-90000 | Operator's Manual |
| 1 | G4218-85000 | Caffeine Standard 250 µg/ml in water |
| 1 | G4218-6800x | Accessory Kit consists of:<br>1 Power cable<br>1 Auto-zero cable<br>1 Signal cable<br>1 RS-232 cable<br>1 External event cable<br>6 mm O.D. gas tubing (2 meters + 1 meter sets)<br>1 set of replacement fuses<br>1 Drain tube, including seal Ferrule and fitting |
| 1 | G1946-60111 | Drain bottle assembly |

**Table 2** Components Shipped with the Agilent 1200 Series Evaporative Light Scattering Detector

| Quantity | Part Number | Description |
|---|---|---|
| 1 | G1312-67305 | Capillary, 600 x 0.17 mm |
| 1 (500 cm) | 0890-1727 | Tubing 5m |
| 1 | 5061-3378 | Cable, remote (APG) |
| 1 (optional) | G4218-60100 | Gas regulator with filter 0.01 µm and manometer |
| 1 (optional) | see Table 13 | Nebulizer |

Agilent Technologies provides a wide range of accessories (e.g. Gas Regulator with Filter and Manometer (part number G4218-60100) to support the operation of the detector. A complete listing of all spare parts and accessories is included as Chapter 9.

### Damaged Packaging

Upon receipt of your detector, inspect the shipping containers for any signs of damage. If the containers or cushioning material are damaged, save them until the contents have been checked for completeness and the detector has been checked mechanically and electrically. If the shipping container or cushioning material is damaged, notify the carrier and save the shipping material for the carriers inspection.

### Delivery Checklist

Ensure all parts and materials have been delivered with the detector. The instrument box contains the instrument and an Accessory kit. A separate box contains the reference manual and the power cable.

Table 2 on page 32 lists the content of each accessory kit.

Please report missing or damaged parts to your local Agilent Technologies sales and service office.

# Installing the Detector

**CAUTION**

*„Defective on arrival problems“*

If there are signs of damage to the autosampler, please do not attempt to install the detector. Inspection by Agilent is required to evaluate if the instrument is in good condition or damaged.

=> Notify your Agilent sales and service office about the damage.

=> An Agilent service representative will inspect the instrument at your site and initiate appropriate actions.

=> It is recommended that the shipping carton be retained as it can be used if it should become necessary to transport the system.

**Table 3** Parts required:

| Quantity | Part Number | Description |
|---|---|---|
| 1 | See Table 13 | Nebulizer |
| 1 | G4218-40000 | Nebulization chamber, glass |
| 1 | G4218-90000 | Operator's Manual |
| 1 | G4218-6800x | Accessory Kit consists of:<br>1 Power cable<br>1 Auto-zero cable<br>1 Signal cable<br>1 RS-232 cable<br>1 External event cable<br>6 mm O.D. gas tubing (2 meters + 1 meter sets)<br>1 set of replacement fuses |

## Gas Supply

The unit is connected to the gas supply via the 6 mm plastic tubing (supplied) using the fitting on the upper left corner of the supply panel on the back of the detector (Figure 8)

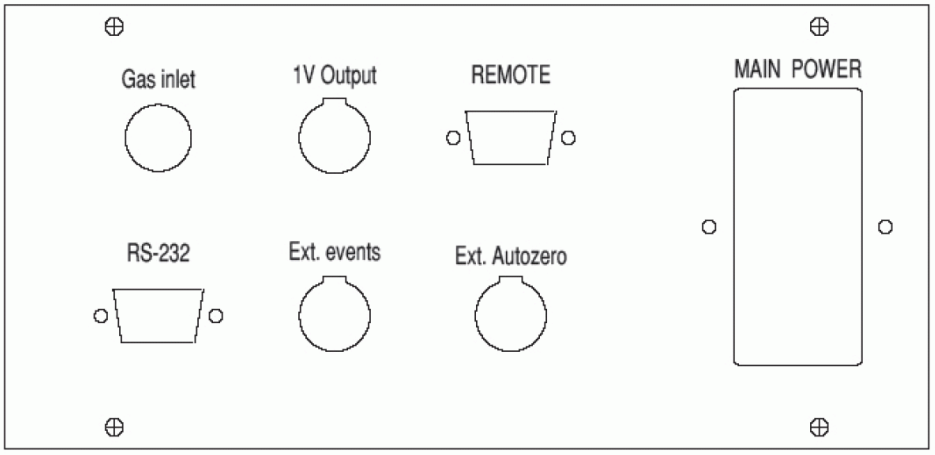


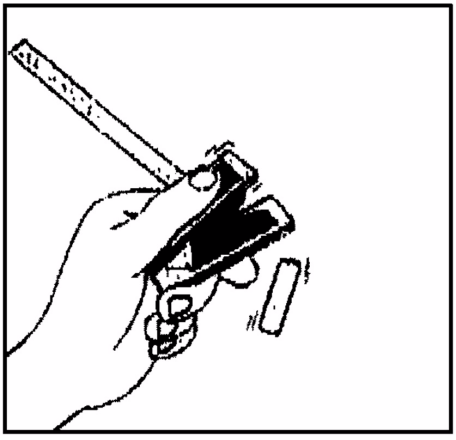

**Figure 8** Supply Panel

### Inserting the gas inlet tube

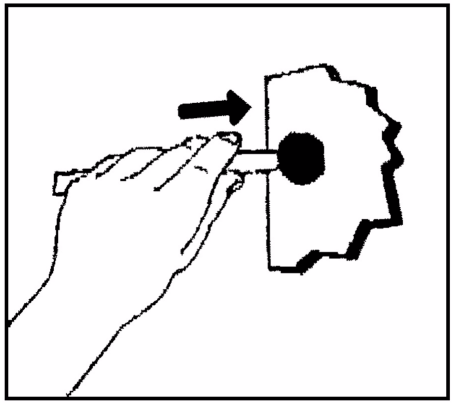
**NOTE** Ensure that Parafilm™ is removed from exhaust tube and drain tubing before installing unit.

**1** The tubing should be cut and firmly inserted into the fitting as shown, after removing Parafilm™ from detector gas inlet.

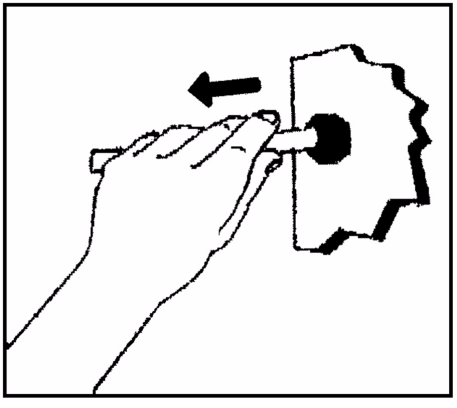
**2** Cut the tube square.



**3** Insert the tube into the fitting until it bottoms.



**4** Pull the tube to check engagement of the grab



**WARNING**

***Tube damage or inappropriate installation***

**Health risk due to gas leakage.**

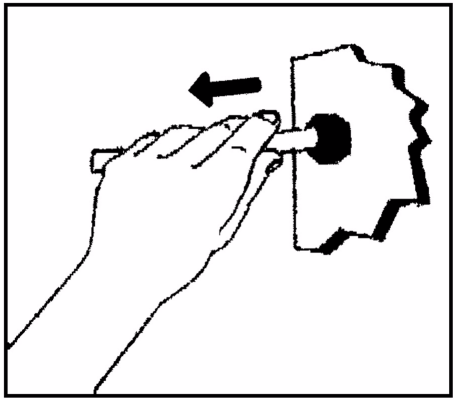
=> Make sure that no tube damage or inappropriate installation could allow a gas leak in laboratory.

Two pieces of tubing are provided. If you are using the system with an external filter, connect the gas source to the filter and then connect the filter to the back of the unit. Make sure that no tube damage or inappropriate installation could allow a gas leak in laboratory.

### Removing the Gas Inlet Tube

To remove the gas inlet tube (if necessary)

**1** dissengage the grab ring teeth by a simple manual pressure on the push sleeve and withdraw the tube from the fitting.



## Vent the Exhaust Line to a Fume Hood

1 Vent the black exhaust tube on the back of the unit to a fume hood, exhaust line or similar installation.

2 Make sure that the fume hood withdraws gas from the detector (i.e. there should be a positive pressure between the detector and the hood).

**WARNING**

***Danger of poisoning and fire hazard***

**The exhaust coming from the detector contains evaporated solvent and sample. Many HPLC solvents like acetonitrile or methanol are toxic and inflammable.**

=> Verify that no tube damage or inappropriate installation could allow a gas leak in laboratory.

**CAUTION**

*Contamination of detector*

If gas from the hood enters the detector, it is possible that foreign material from the hood could contaminate the detector.

=> Avoid negative pressure between the detector and the fume hood.

3 Install the vent tube so that it cannot become blocked or bent

**CAUTION**

*Bias of measurement results*

Turbulences in the glass cell siphon, liquid spilled into the heating tube or contamination of the detector.

=> Make sure the negative pressure of hood or exhaust line is not too strong such that no air is drawn in from the leak drain.

4 The vacuum must be moderate to avoid turbulence in the glass cell siphon.

5 Using the drain bottle assembly G1946-60111 and included tubing is recommended as a condensation trap and for pressure compensation. Avoid long tube installations in upward direction creating condensation dropping back into the detector. Avoid loops or bends in the tubing which form condensation traps causing bad measurement results.

# Electrical Connections

All electrical connections are made via the supply panel (Figure 8).

1. Use the RS-232 (serial) connection as a standard connection to a control PC with Agilent Chemstation control and data evaluation software. Different options are available for connections to third party devices, see Appendix 4.
2. Connect the detector to your personal computer via the RS-232 port using the cable supplied with the instrument. If you use a different cable make sure to use a straight RS-232 cable, which directly connects pins of same numbers. Most RS-232 cables are cross-over or null modem cables and cannot be used for this connection.
3. Connect the ELS detector to the APG remote control of your LC modules. Use the supplied cable (Cable remote 5061-3378) and plug it to the connectors labeled with "REMOTE". Not using the APG connection will impair the retention time reproducibility.
4. Place the ON/OFF switch to the OFF position and plug the power cord into the socket on the rear panel of the detector.

**NOTE** Do **not** turn on the power at this time.

5. Connect the three wires of the power cord of this system to a grounded line. All components of the chromatographic system should be connected to a common ground. If a two wire outlet is used, make sure that an adapter is used to connect the third wire to ground.

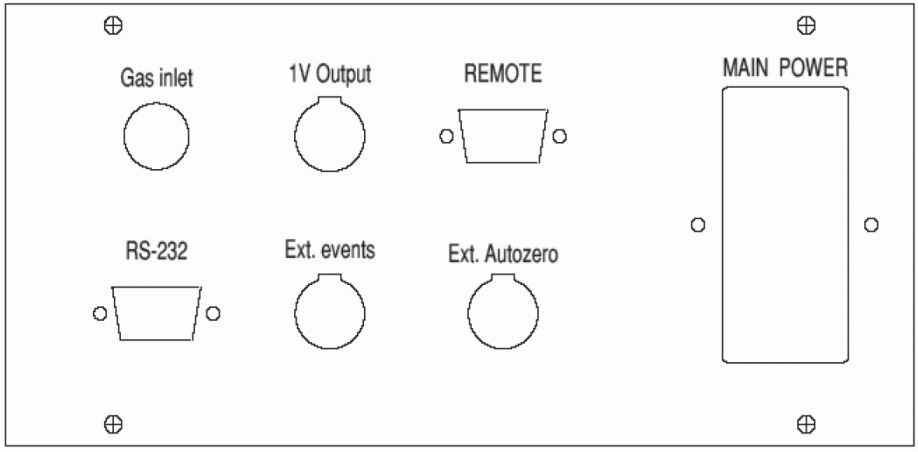



**Figure 9** Supply panel

# Additional Options

Use the RS 232 cable as a standard connection to a control PC with Agilent Chemstation control and data evaluation software.
All electrical connections are made via the supply panel (Figure 10).

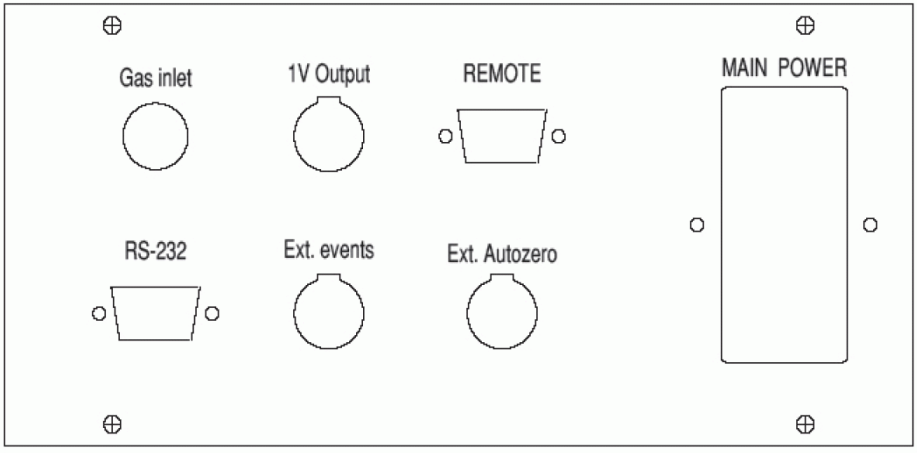



**Figure 10** Supply Panel

### Connecting the Recorder/Integrator

If a recorder or integrator is employed, connect the recorder input to the 1 V output terminal on the rear panel of the detector (Figure 10) and to the appropriate socket on the recorder/integrator.

### Connecting the External Autozero

If the external autozero function shall be used, plug the cable that is supplied into the *Ext Autozero* socket on the detector (Figure 10) and to the appropriate socket on the controlling device

Use a contact closure or TTL signal for auto-zeroing the detector.

Do not install the autozero cable if not needed. An unintentional short circuit of the loose ends will result in a contiuous zero signal.

If a TTL signal is used please make sure to use the correct polarity identified on the cable.

Refer to “External Auto-zeroing of the Detector” on page 53 to operate external autozero contact closure.

### Connecting the External Events Cable

If the external events functions shall be used, plug the cable that is supplied into the appropriate socket on the rear panel of the detector (Figure 10) and to the appropriate socket on the controlling device.

The white cables are contact closure "output" cables that provide the ready/non-ready information to an external device. The detector will be in the "not-ready" mode (the contact will be in closed position) if any of the following conditions is observed:

- The lamp is off
- The temperature is not at the indicated setpoint
- The temperature is at the indicated setpoint but is not stable
- The pressure is below 3.0 bar

**NOTE** The controlled device electrical consumption mustn't exceed 20 mA under 12 V DC.

The blue cables are contact closure "input" cables that are used to power the unit down (see “The Gas Valve Screen” on page 165) via a signal from an external device to the detector.

A contact closure signal must be used from the controlling device to short circuit the contacts. If a TTL signal is used please make sure to use the correct polarity identified on the cable.

- RS-232 Port

  If a personal computer is used with the detector, the detector should be connected to the computer via the RS-232 port using the supplied cable.

### Connecting the Power Cord

Place the ON/OFF switch to the OFF position and plug the power cord into the socket on the rear panel of the detector.

**NOTE** Do not turn on the power at this time.

The power cord of this system contains three wires which must be connected to a grounded line. All components of the chromatographic system should be connected to a common ground. If a two wire outlet is used, make sure that an adapter is used to connect the third wire to ground.

# Installing the Nebulizer and Nebulization Chamber Assembly

Parafilm™ is used to cover various openings inside the compartment, nebulizer and nebulization chamber to prevent dust particles from entering the system during shipment.

The installed Nebulizer/Nebulization chamber assembly is shown in Figure 11.

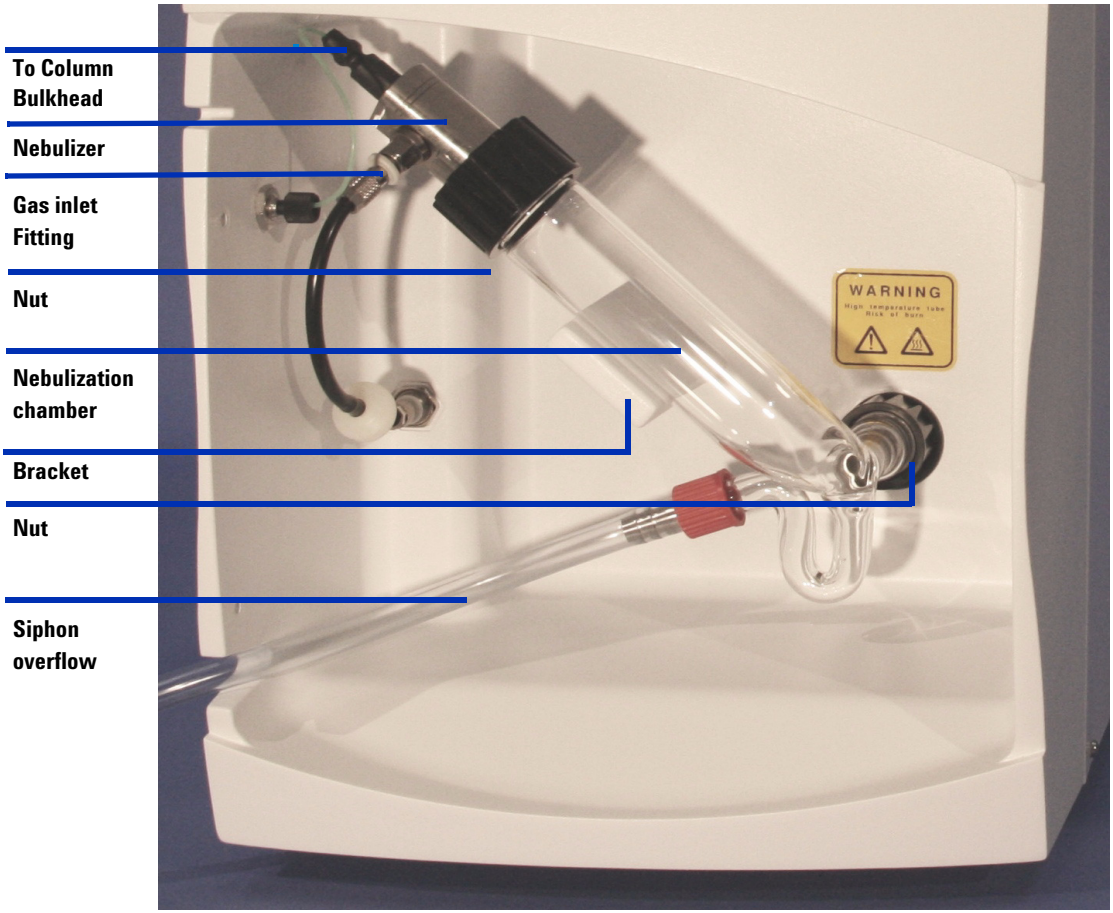



**Figure 11** Installing the nebulizer/nebulization chamber assembly

To install the assembly:

1. Remove the Parafilm™ on all detector openings and on the nebulizer cell (these coatings are used to prevent dust particles from entering the system during shipment).
2. Position the nebulization chamber as shown in Figure 11 and tighten the black nut at the bottom. The nebulization chamber is in the correct position, if it is in contact with the back wall as shown in Figure 12.

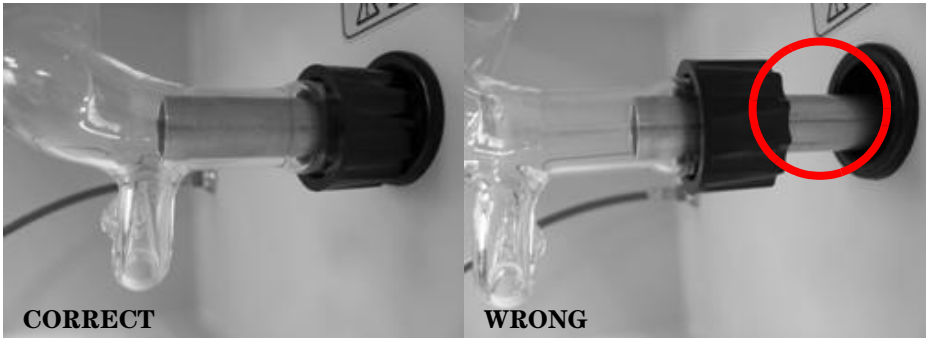



**Figure 12** Fixing the Tip of Nebulization chamber

3. Use the large black nut to position the nebulizer on the nebulization chamber.
4. Screw the inlet fitting into the bulkhead on the left side of the compartment. Special care must be taken when positioning this fitting. The nebulizer is terminated with a small piece of Teflon tubing with an outer green sleeve. For proper operation, the Teflon tubing must extend less than 2 mm past the end of the green sleeve (Figure 13).

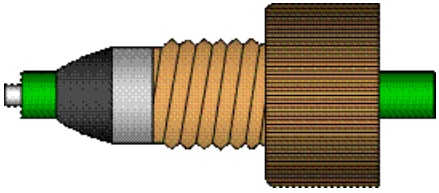


**Figure 13** Nebulizer Inlet Fitting

**WARNING**

***Health risk caused by liquid leaks***

**Liquid leaks could cause personal injury or laboratory pollution or negatively affect the detector performance due to a loss of liquid.**

=> Make sure that all connections are tight and that there is no liquid leak.

---

**5** Fill the siphon overflow on the nebulizer/glass tube assembly with the mobile phase that will be used for the separation. If you are using a highly volatile solvent like hexane or CH2Cl2, use water to fill the overflow. The liquid should fill the bent part of the siphon, but should not pool in the bottom of the condenser tube.

## Connecting the Siphon Overflow

1. Attach the Tygon™ drain tube assembly to the end of the siphon tube using the tapered hose connector and lead the tube to a waste container.
2. Locate the tube in such a way that condensed solvent can flow freely from the siphon and ensure that the end of the tube is not immersed in the collected liquid. Make sure that the liquid container is appropriate for the solvents used.
3. Ensure that no siphon liquid leak could affect detector performances or create a laboratory pollution.

   If the solvent that you are using is not compatible with Tygon™ (e.g. THF), use instead a piece of Teflon tubing or any material that you know is compatible with your solvent.

**WARNING**

***Toxic and hazardous solvents***

**The handling of solvents and reagents can hold health risks.**

=> When opening capillary or tube fittings solvents may leak out.

=> Please observe appropriate safety procedures (for example, goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet supplied by the solvent vendor, especially when toxic or hazardous solvents are used.

## Connecting the Nebulization Gas to the Nebulizer

1. Attach the nebulization gas tube coming out of the front panel to the nebulizer gas inlet fitting located on the nebulizer side as shown in Figure 11.

## Connecting the Column

1. Attach the fitting from the bulkhead to the end of the column.

# Powering Up the Unit

1 Place the ON/OFF switch to the OFF position and plug the unit into the wall.

2 Turn on the unit via the ON/OFF switch.

The display will present the firmware version number and date it was created for a few seconds (the version number should be recorded as it may be required for service or troubleshooting) and will then present the signal (which should be 0 or very close to it), the temperature (which should be the ambient temperature), the pressure (which should be zero or very close to it) and the gain.

Refer to Chapter 4 for preparing the unit for routine operation.

# 4
# Using the System



This chapter describes the operations that should be performed on a routine basis when you want to collect chromatographic data using the Agilent 1200 Series Evaporative Light Scattering Detector. In this discussion, we assume that you have demonstrated that the system is operating in an acceptable manner (see Chapter 4) and that the general chromatographic conditions for the separation have been determined.

# Preparing the System for Operation

To prepare the system for operation:

1. Power up the detector by pressing the switch on the rear panel.
2. Open the gas distribution valve and set the pressure to 3.5 bar (51 psi). The pressure is indicated on the **Status** screen.
3. Ensure that the overflow siphon for the nebulization chamber contains sufficient liquid. If necessary, pump a few ml of solvent through the system to fill the nebulization chamber.
4. Select the desired temperature using your control software or the instrument control (see Appendix 10). The temperature is set on the **Temp/Gain** screen, which is accessed by pressing the  button two times when the **Status** screen is presented.
5. Start the mobile phase flow through the system and allow the overall system to operate for at least 15 minutes to ensure that all components are equilibrated and a stable baseline is obtained.
   Please refer to Chapter 5 for choosing temperature settings, solvents and columns.

# Auto-zeroing the Detector

## Manual Auto-zeroing of the Detector

To auto-zero the detector:

1 Set the **Gain** to the desired value. The gain is set on the **Temp/Gain** screen, which is accessed by pressing the  button two times when the **Signal** screen is presented.

2 Press the  button. The detector will be automatically auto-zeroed at this point.

3 If the signal is to be offset, set the offset at this time. The **Offset** screen is accessed by pressing the  button when the Status screen is presented.

**NOTE** The offset must be selected after the detector is auto-zeroed, as the auto-zero operation sets the signal to 0.

**NOTE** If you change the gain selection, make sure that the system is auto-zeroed again before taking any measurements.

## External Auto-zeroing of the Detector

If desired, the auto-zero command can be initiated by an external device such as the HPLC system controller. To employ this feature, a cable from the external device is plugged into the EXT AUTO ZERO socket on the rear panel. See “Electrical Connections” on page 40.

# Routine Operation of the System

In general, operation of an HPLC system with evaporative light scattering detection is similar to operation of the system with other detectors.

During operation of the system, the following points should be considered:

**WARNING**

***Health risk by exhaust gas***

**Exhaust gases could cause personal injury or laboratory pollution when it is lead into the laboratory.**

=> Make sure that the exhaust gas from the detector is led into a fume hood or other device.

---

✔ Make sure that the exhaust from the detector is led into a fume hood or other device and make sure that there is a continuous flow of gas through the system (i.e. no constrictions or condensation traps), see Chapter 3. If a vacuum is used, ensure that the vacuum effect will not disturb the detector.

**WARNING**

***Health risk by potential leakage of hazardous solvents***

**Leakage of hazardous solvents could cause personal injury or laboratory pollution by pressed out liquid.**

=> Make sure all flow connections to and inside the detector are tight.

=> After having switched on the LC pump for several minutes, verify that there are no leaks.

=> In case of any leak, switch off the pump immediately and remove the liquid.

---

✔ Ensure that the siphon is filled with liquid at all times. The overflow from the siphon should be collected in a suitable waste container by using the drain tube.

✔ Never exceed a gas pressure of 4.5 bar (67 psi).

✔ Avoid the use of solvent or samples that could corrode the detector. The mobile phase is in contact with glass and Teflon tubing and the evaporation tube is constructed from stainless steel. See “Solvent Information” on page 174.

# Installing Test Procedure

In order to verify the correct operation of the instrument, this test procedure is used. During this test, a standard sample is run under defined conditions and the result is inspected visually by comparing it to a reference measurement. This test is not intended as a replacement for a full IQ or OQ procedure, which is available as a service from Agilent and provides quantitative results.

For running the test, please use the following measurement conditions:

**Table 4** Measurement conditions for test run

| | |
|---|---|
| Sample | Caffeine standard 250 µg/ml in water (p/n G4218-85000) |
| Solvent | Isocratic, 80% water, 20% Acetonitrile |
| Flow | 1 ml/minute |
| Injection volume | 20 µl |
| Column | Eclipse XDB-C18 4.6x150 5u Analytical |
| TCC temperature | 35 °C |
| ELSD temperature | 35 °C |
| ELSD pressure | 3.5 bar (51 psi) |
| ELSD gain | 7 |
| System | Agilent 1200 Series Standard LC System with Standard Degasser, Binary Pump, High Performance Autosampler, Thermostatted Column Compartment and Diode Array Detector |

After turning on the detector, allow 15 minutes for equilibration. Monitor the temperature using the Chemstation online signal display or the instrument display. As soon as the target temperature is reached and stable, start a method run using conditions listed in Table 4.

A chromatogram similar to the one in the following figure can be expected. Please note that retention time, peak area and peak shape can vary and depend on the individual HPLC system configuration.

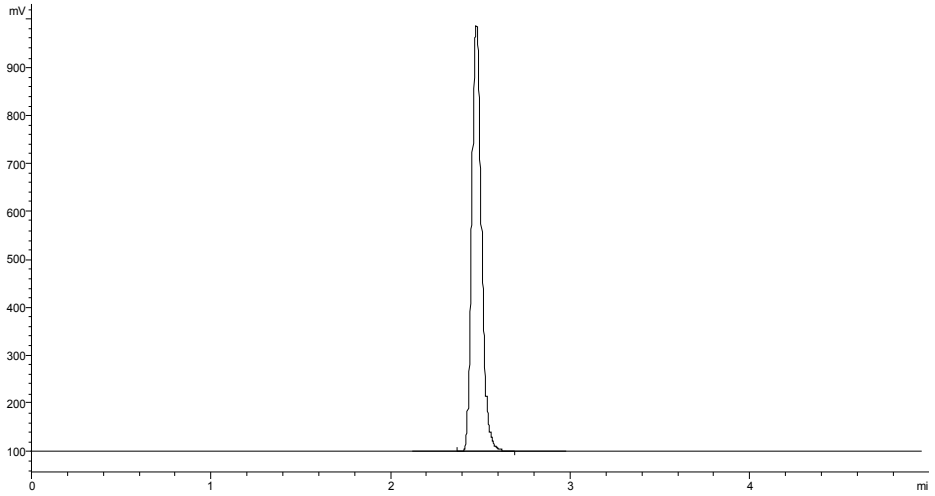



**Figure 14** Typical chromatogram for caffeine, see measurement conditions in text

# Powering Down and Shutting Down the System

If desired, some or all functions of the system can be powered down at the end of an automated series of analyses. These power down features are described in detail in "The Gas Valve Screen" on page 165.

**To shut down the system:**

1. Turn off the pump.
2. Allow the nebulization gas to flow through the detector for a few minutes to drain the evaporation tube and detection chamber.
3. Turn off the power to the detector (if desired).

**NOTE** If you are using a mobile phase which contains salts, acids or bases, pump a few ml of water or methanol through the system before turning off the detector to prevent the deposition of substances and corrosion of the system.

If the ELSD is used as a second detector and is not used for some time, it is recommended to remove it from the liquid chromatography flow path in order to avoid blockage of the nebulizer or deposition of substances in the detector.

If the detector is turned off, it must be removed from the software configuration for avoiding problems due to a missing instrument (power failure).

### Cleaning the Detector

After each session and before ending HPLC use, the whole HPLC system including the ELSD should be cleaned in order to ensure good performance. For the ELSD preventive maintenance consists in cleaning the detector before shutting down after last analyses:

1. Let mobile phase or solvent flow to flush particles which could remain.
2. Eventually increase temperature in order to dissolve possible deposit.
3. Stop the mobile phase flow but let gas flow to dry to avoid particles deposit.
4. Stop the gas flow.
5. Shut down the detector.

The time required for each step depends on the application, used solvents, type and concentration of samples and should be determined practically.

# 5
# Optimizing Performance

# Selecting the Optimum Temperature

There are two factors that should be taken into account when selecting the optimum temperature for the detector:

- increasing temperature will optimize the evaporation of the mobile phase.
- decreasing temperature will minimize the decomposition of thermally labile compounds and the volatilization of semi-volatile compounds.

A very reasonable start is to set the temperature to 60°C if an aqueous mobile phase is used and 40°C if an organic mobile phase is used (these temperatures are suggested for a flow rate of 1 ml/min). At higher flow rates, more elevated temperatures may be required for minimizing the noise.

**NOTE** If a mobile phase such as DMSO or DMF has a relatively low volatility, temperature should be increased to allow correct evaporation process.

The temperature can be adjusted easily during the method optimization process.

If you suspect that the compound of interest is thermally labile, a lower temperature could be used to improve the sensitivity by reducing the thermal decomposition. For a given flow rate and solvent, there is, however, a point at which the noise in the chromatogram is dramatically increased because not all of the mobile phase is vaporized.

As an example, consider the analysis of caffeine with evaporation temperatures of 35 °C and 60 °C (see “Installing Test Procedure” on page 56, Table 4). It is clear that the use of a low temperature provides significantly better sensitivity for volatile and thermally sensitive compounds.

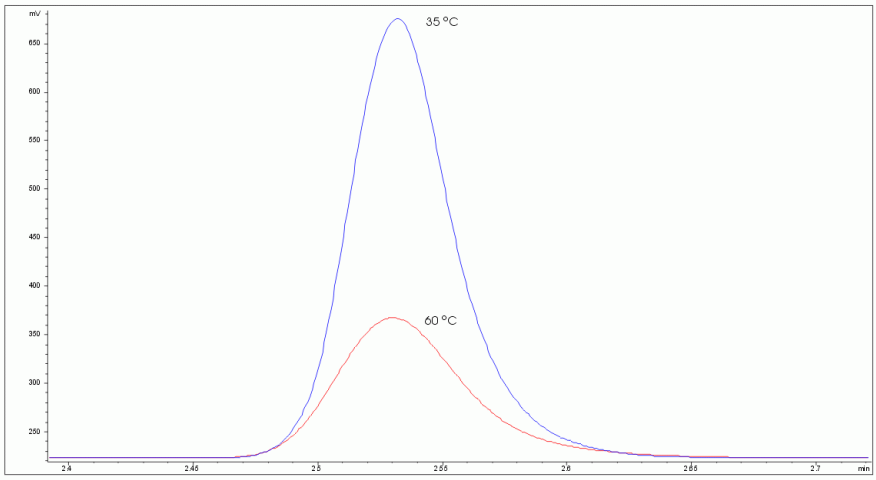



**Figure 15** Chromatogram of Caffeine at Various Temperatures

The minimum temperature that can be used depends on the flow rate and the nature of the mobile phase.

# Optimizing the Mobile Phase

Particulate matter in the mobile phase will increase the background and the noise.

The purity of the solvent is a critical issue in the noise. In general, filtering of the solvent is not recommended as the solvent may extract contaminants from the filter.

In most cases, distilled water and HPLC grade solvents are satisfactory. If you are comparing solvents, the most critical parameter is the Residue after Evaporation; this parameter should be less than 1 ppm to maximize the sensitivity of the detector.

The mobile phase should not contain non-volatile solvent modifiers. Volatile solvent modifiers (e.g. $CF_3COOH$, $CH_3COOH$, $(C_2H_5)_3N$) can be used, but they may increase the noise level at high gain settings. In addition, the solvent should not contain preservatives, (e.g. tetrahydrofuran contains BHT as a stabilizer).

The parts of the detector which are in contact with the solvent and sample are made of Teflon, stainless steel, and glass. Make sure that the solvents are compatible to these materials.

**NOTE** Depending on the mobile phase nature and flow rate, the suggested gas pressure 3.5 bars (51 psi) may have to be adjusted in order to optimize the background noise and the signal-to-noise ratio.

## Sample Pre-Treatment

If the sample contains insoluble particles, it should be filtered through a 0.2 µm or 0.45 µm filter before injection.

## Column Treatment

The chromatographic column typically contains micro-particles which are used to separate the compounds of interest. In some cases, such particles may be eluted from a column and enter the detector, which may increase in the noise.

The degradation of column packing material depends on a variety of factors including the particle size, type of column packing and the nature of the mobile phase (e.g. a high pH may degrade silica based columns).

After you have installed a new column, it is recommended that you pump mobile phase through it for a few minutes before connecting it to the detector. This will flush out micro-particles that may reside in the column from the manufacturing or shipment process. It is suggested that you perform the Column Noise test (see "Column Noise Test" on page 79) to obtain the baseline signal value for the column.

# Optimizing the Filter

The Digital Filter (see "The Noise Filter/Pressure Unit Screen" on page 163) allows maximizing signal-to-noise ratio by filtering noise. The filter length should be optimized according to peak shape, and more specifically to peak width.

The following table suggests some Filter settings depending on peak width :

**Table 5** Digital Filter suggestion versus Peak Width

| Peak width at 50% (Seconds) | Suggested filter (Seconds) |
|---|---|
| <1 second | 0 second |
| 2 | 1 |
| 4 | 2 |
| 6 | 4 |
| 8 | 6 |
| >10 | 8 and higher |

These suggested values can be optimized depending on your specific chromatography, by decreasing the filter length if peaks are poorly resolved (e.g. if Rs<1.5), or increasing Filter when optimizing Signal to Noise ratio.

Example: Comparison of digital filters using the SOP test (injection of 5 ppm glucose at gain 12). Peak width at half-height is 2.5S.

**Table 6** Sensitivity improvement depending on Filter

| | Filter 0S | Filter 1S | Filter 2S |
|---|---|---|---|
| Signal height | 124 mV | 122 mV | 110 mV |
| Noise (ASTM) | 3.2 mV | 1.1 mV | 0.7 mV |
| Peak width (at 50% height) | 2.5 seconds | 2.5 seconds | 2.8 seconds |
| S/N | 37 | 110 | 157 |

Signal to noise ratio is multiplied by 3 when choosing Filter 1S without any peak broadening effect. If Signal to Noise ratio is more important than resolution, a Filter 2S or higher can be set to improve sensitivity even more.

# 6
# Troubleshooting and Diagnostics



This chapter describes troubleshooting activities which are useful for determining the cause of wrong or unexpected.

# Basics of Troubleshooting

The Agilent 1200 Series Evaporative Light Scattering detector is designed to be used with a liquid chromatography system. For troubleshooting, it is important to distinguish between detector issues and issues with other parts of the system, which might affect detector output.

Troubleshooting refers to the task of finding the reason for an abnormal response from the system and the following guidelines should be used to determine the problem:

✔ It is important to recognize that in almost all cases there are several possible causes for a problem. As an example, an increase in the noise of the chromatogram could be due to

- a defective nebulizer
- the slow elution of very tightly retained material from the column
- a unsuitable mobile phase (non-volatile buffers, high dry residue amount)
- an increase in pump pulsation
- the solvent e.g. improper degassing or high residue after evaporation
- the pump, e.g. a defective check valve
- the detector, e.g. an electronic problem
- the gas supply, e.g. particles in the gas line.

✔ Check the nebulizer. The flow from the nebulizer should be fine and homogeneous. If it is not, the nebulizer, the needle or the Teflon tube may be obstructed with foreign material.

It is rather unlikely that two problems occur at the same time. The role of the troubleshooting activities is to determine the cause of the problem. In this discussion, we will assume that the operator has determined that other components of the system are operating properly.

**WARNING**

***Destruction of the nebulizer by disassembly***

**Disassembling the nebulizer will lead to its destruction.**

=> Do not disassemble the nebulizer.

**NOTE**

The control panel and system electronics do not contain any replaceable components. If the suggestions provided in this chapter do not remedy the problem, contact your Agilent service representative.

If the digital display does not illuminate when the system is powered up, turn the unit off and inspect the main fuses. If necessary, replace the fuses with some of the same rating as the original fuse (3.15 AT (time-delayed), part number G4218-68005) for units of all voltages. The fuses are located inside the main power module on the rear panel (Figure 8). A set of replacement fuses is delivered in starting kit.

If the fuses are not blown or if the replacement fuses blow up, contact your Agilent service representative.

## Initial Troubleshooting Activities

- ✔ Make sure that the instrument and all components of the system are grounded properly.
- ✔ Ensure that the liquid level in the siphon is appropriate, and that there is no liquid accumulating in the nebulization chamber.
- ✔ Check that the gas pressure is sufficient (3.5 bar target, 3 bar minimum, 4.5 bar maximum) and is stable. The gas filter should be clean and in place.
- ✔ Ensure that the flow rate of the pump is constant and check that there are no leaks in the chromatographic system.

## If there is no response from the system

If there is no response from the system when the unit is powered up (e.g. the fan does not rotate, the display does not light up, the light source is off, etc.) it is likely that the instrument is not getting power.

- ✔ Check that the unit is plugged into an active mains line.
- ✔ Check that the mains line voltage corresponds to the detector voltage version.
- ✔ Disconnect the system from the power line and check the mains fuses. The mains fuses are in the vicinity of the power line socket as shown in Figure 16. Pry the plastic cover off the fuse holder to access the fuses and inspect them. If a fuse(s) is blown, replace it with one of the same rating (T3.15 AL/230V, part number G4218-68005

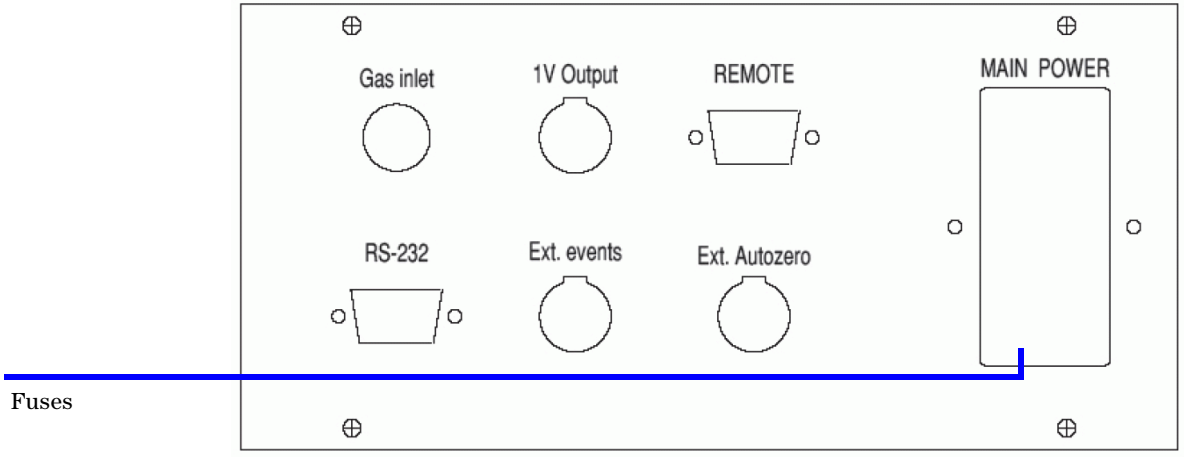



**Figure 16** Control Panel

## Perform the Noise Tests

Repeat the tests described in “Perform the Noise Tests” on page 71 and compare the observed data to the limits defined for these values

For example, if the Electronic Noise test (see “Electronic Noise Test” on page 75), Background Noise test (see “Background Noise (Stray Light) Test” on page 76) and Solvent Noise test (see “Solvent Noise Test” on page 77) provide results which are well within limits but the Column Noise test (see “Column Noise Test” on page 79) fails or is significantly different from values obtained for comparable measurement conditions (same system setup, solvent column), it is likely that the problem is due to the column (e.g. highly retained compounds are being eluted).

# Specific Detector Troubleshooting

✔ If the mist of the nebulzer is not homogeneous, the nebulizer, the needle or the Teflon tube may be obstructed. To remove the obstruction, pump a solvent that can dissolve the foreign material. As an alternative, the nebulizer can be placed in an ultrasonic bath to dissolve the foreign material. Instructions abo"Column Noise Test" on page 79ut cleaning of the nebulizer for cleaning are presented in "Cleaning the Nebulizer" on page 103.

**NOTE** Do not disassemble the nebulizer, this will void the warranty

✔ If the sensitivity of the system is low, ensure that there are no leaks in the system. In some cases, a small increase in the gas pressure (e.g. 0.1 or 0.2 bar) may solve the problem. Alternatively, a new LED may be required or the nebulizer might be obstructed.

✔ If the detector signal is saturated or if there is a decrease in the dynamic range of the system, it is possible that a residue is passing through the detector cell; this will lead to an intense signal due to a significant amount of light scattering. This residue may be derived from the elution of strongly retained materials from the column, or may be derived from the solvent. For determining the cause of the problem, bypass the column and observe the signal intensity:

- if the signal returns to normal, strongly retained materials are eluting from the column. Flush the column with a strong solvent to elute all material.
- if the signal does not return to normal, the solvent contains a residue material and is not suitable for use with the detector.

✔ If the noise of the system without solvent is high or if ghost peaks occur, it is possible that foreign material is present in the drift tube. In this situation, increase the temperature to 90°C and pump solvent at the rate of 2 ml/min, using a gas pressure of 3.5 bar (51 psi).

# Noise test procedures

This section describes some procedures, which can be helpful for troubleshooting and help the user to distinguish detector issues from issues caused by other elements contributing to the measurement result like solvents or the column. Four tests are described, which add more of these elements step by step, so their contribution can be measured.

- ✔ The electronic noise test measures the signal created by the detector without irradiation and solvent flow. (See “Electronic noise test” on page 80).
- ✔ The background noise/stray light test measures the signal measured by the detector, while the light source is on, but no sample or solvent flow through the detector. (See “Background Noise (Stray Light) Test” on page 76).
- ✔ The solvent noise tests measures the signal created by pure solvent flowing through the detector while no column is installed. (See “Solvent Noise Test” on page 77).
- ✔ The column noise test measures the signal created by pure solvent flowing through the column and the detector. (See “Column Noise Test” on page 79).

## Preliminary Activities

**NOTE** Before starting the tests for new instruments or after storage, flush detector with water at a flow of 1 ml/min for at least 15 minutes.

The following activities should be performed:

1 Power up the instrument.

2 Set the gain to 1 and the offset to 0 mV. The **Signal** screen should indicate 000 (or a very small signal).

3 Access the **Temperature/Gain** screen, set the temperature to 50°C and press AZ .
View the **Status** screen and verify that the temperature is rising to the setpoint on the **Status** screen.

4 Provide gas to the detector and adjust the pressure to 3.5 bar (51 psi). If the pressure is less than 3 bar (44 psi), an error message will be presented indicating that the detector is not ready.

**CAUTION** *Damage of pressure sensor*

Pressures above 4.5 bar (67 psi) can damage the pressure sensor of the detector. The gas consumption for the large nebulizer is 4 l/min and 3 l/min for all other nebulizers. The target pressure for most applications is 3.5 bar (51 psi).

=> Do not switch on the gas flow suddenly, as this may cause the exceeding of maximum pressure. The use of a separate pressure regulator is highly recommended. A filter (0.01 µm) and manometer (part number G4218-60100) is available as an option. Replacement filter cartridges are available as part number G4218-40150.

5 Press the AZ button.
The signal should read close to zero and remain constant.

6 Set the noise filtering to **1S** (see "The Noise Filter/Pressure Unit Screen" on page 163).

# Electronic Noise Test

**NOTE** For this test, do not turn on the light source. Do not turn on the HPLC pump (no solvent flow).

To determine the electronic noise:

1. Make sure the siphon is filled and the bulkhead is blocked with a blank nut or Parafilm™ to avoid a Venturi effect.
2. Switch on the gas flow at 3.5 bar (51 psi).
3. Set the temperature to 50 °C. Wait for stable temperature.
4. Set the Gain to 12.
5. At gain 12, monitor the signal for a period of 5 min. The variation in the signal should be less than +/- 2 mV (there may be some spiking of the signal).
6. Record the level and autozero the detector again.

# Background Noise (Stray Light) Test

**NOTE** For this test, the HPLC pump must be off (no solvent flow).

To determine the background noise :

1. Make sure the siphon is filled and the bulkhead is blocked with a blank nut or Parafilm™ to avoid a Venturi effect.
2. Switch on the gas flow at 3.5 bar (51 psi).
3. Set the temperature to 50 °C. Wait for stable temperature.
4. Switch on the light source.
5. Set the Gain to 1.
6. Set the offset to 0 mV.
7. Wait 15 minutes for stabilization and record the signal level.
8. Increase the gain to 12 and monitor the signal.
   The expected level is typically 100 mV to 150 mV.

## Solvent Noise Test

To determine the solvent noise:

1. Make sure the siphon is filled and the bulkhead is blocked with a blank nut or Parafilm™ to avoid a Venturi effect.
2. Switch on the gas flow at 3.5 bar (51 psi).
3. Set the temperature to 50 °C. Wait for stable temperature.
4. For now, keep off the HPLC pump.
5. Switch on the light source.
6. Set the gain to 12 and monitor monitor the signal.
   Do not autozero the detector. The signal may be negative.
7. Bypass the column of your HPLC system.
8. Connect the detector to the mobile phase delivery system and pump the solvent that you expect to use for your analyses through it at a flow rate of 1 ml/min.
9. Monitor the baseline for a few minutes.
   - If water is used as the solvent, the signal should be 10 mV or less. Higher values could be observed if non-HPLC grade water is used, which may have a higher non-volatile residue.
   - If an organic solvent is used, the signal should be 200 mV or less.
   - For mixtures of water and organic solvents, the expected signal can be estimated by linearly interpolating to the concentration of organic phase in the solvent (e.g. a mixture of half and organic solvent (50:50) should provide a signal of approximately less than 105 mV).

If the instrument fails the Solvent Noise test, it is most likely due to an impurity in the solvent rather than a fault with the instrument. A different supply of solvent should be obtained and employed (MS grade solvents or lowest dry residue (< HPLC grade) solvent should be used for this test).

The purity of the solvent is critical for a low background noise. In most cases, distilled water and HPLC grade solvents are satisfactory. When you are comparing solvents from different sources, the most critical parameter is the *Residue after Evaporation*; this parameter should be less than 1 ppm to maximize the sensitivity of the detector. Mass spectroscopy grade solvents have a very low dry residue.

The mobile phase should not contain non-volatile solvent modifiers. Volatile solvent modifiers (e.g. $CF_3COOH$, $CH_3COOH$, $(C_2H_5)_3N$) can be used, but they may increase the noise level at high gain settings. In addition, the solvent should not contain preservatives, (e.g. tetrahydrofuran normally contains BHT as a stabilizer)..

When filtering solvents, only use filters recommended for the use with HPLC systes, as the solvent may extract contaminants from other filters. Stainless steel filters should be preferred over glass filters and others. (HPLC grade solvents or lowest dry residue solvent should be used for this test).

If changing the solvent source does not solve the problem, it may be necessary to decontaminate the system as described in “General inspection” on page 98 or clean the nebulizer as described in “Cleaning the Detector” on page 99.

## Column Noise Test

**NOTE** It is recommended that a specific column is reserved for this test. This column should not be used for routine analyses. If a column is used for a number of different separations, it is possible that some compounds can be tightly bound to it and slowly eluted over time. When tightly bound compounds are slowly eluted from the column, excessive noise will be observed.

To determine the column noise:

1 Turn off the pump and connect the column.

2 Restart the pump and allow the mobile phase to flow through the system. It is suggested that you flush the column with a strong solvent for a few minutes before attaching it to the detector. The flow rate to be applied depends on to the column ID and is indicated in the following table:

**Table 7** Flow rate versus Column diameter indication

| Column ID (mm) | Flow Rate (µl/min) |
|---|---|
| 4.6 | 1000 |
| 2.1 | 208 |
| 1.0 | 47 |
| 0.8 | 30 |
| 0.32 | 4.8 |

3 Set the gain to 12 and monitor the baseline for a few minutes.
A suitable column will provide a baseline that is 20-50 mV above the solvent baseline.

If the instrument fails the Column Noise test, it is most likely the fault of the column rather than the instrument. Obtain a new column and repeat the test.

**NOTE** If the mobile phase contains acidic modifiers (e.g. $CF_3COOH$), disconnect the detector and wash the HPLC system for 12 h before starting to analyze unknown samples. This wash should be performed after the column noise test is completed, but does not need not be performed after each analysis.

# Troubleshooting based on diagnostic tests

If the actions described in the noise test procedures (see “Noise test procedures” on page 73) do not solve the problems of failing tests, following actions should be performed by the service.

## Electronic noise test

In case the electronic noise is higher than expected, see “A noisy signal is observed” on page 82.

## Stray light test

In case the intensity of the stray light/background noise is out of the expected range, see “No signal is observed” on page 81 and “Troubleshooting components” on page 83.

## Failed run of standard sample

In case the noise tests have passed, but the peak area for a standard is lower than previous reference measurements, check the nebulizer (see “Cleaning the Nebulizer” on page 103), make sure you are using a fresh sample and consider running the test using a backpressure loop instead of a column.

# Troubleshooting based on instrument signals

In all cases of troubleshooting for the detector signal, noise tests as described in "Perform the Noise Tests" on page 71 should be run in order to distinguish detector problems from application or system problems and in order to acquire parameters under defined conditions.

## No signal is observed

If no signal is observed:

- ✔ Make sure that the light source is on.
- ✔ Run a stray light test and check, whether the stray light signal for gain 12 is in the range of 100 mV to 150 mV.
- ✔ Check that the gas valve is opened and the pressure regulator is opened (if any). A pressure display that is greater than 0 indicates that there is gas flow.
- ✔ If the stray light test passes and the gas flow is on, the nebulizer is probably blocked. Clean the nebulizer as described in "Cleaning the Nebulizer" on page 103.
- ✔ If cleaning the nebulizer does not solve the problem, replace the nebulizer.

## Decrease in sensitivity

If noise tests did not show that the problem could be caused by the application or system, a decrease in the sensitivity is often caused by the nebulizer (main cause) or the detector sensing section.

If noise tests pass but the signal heights/areas for known standards are too low, the nebulizer might need to be replaced. Please note that the root cause might also be in a different module, e.g. volumes injected by the autosampler might be too low or dead volumes in capillary connections cause peak broadening.

If the stray light test gives signals which are too low

- ✔ Check light source lifetime and replace it if needed. See "Exchanging the light source" on page 131
- ✔ Set the stray light to the original value. See "The Light source Normalization Screen" on page 164

## A noisy signal is observed

**NOTE** High noise is often due to a lack of maintenance. The detector should be cleaned on a routine basis.

If the signal is noisy, apply noise tests in order to ensure that the high noise is not due to the mobile phase or the column. Then:

1. Do a general inspection as described in "General inspection" on page 98
2. Clean the nebulizer as described in "Cleaning the Nebulizer" on page 103.
3. Exchange the nebulizer.

# Troubleshooting components

## Overview

If the instrument powers up and one or more of the components are not functioning properly it is possible that either a component (e.g. the photomultiplier) or a printed circuit board is at fault.

The ALIM 004 and the CTRL005 printed circuit boards have a number of test points and indicator LED's that may be useful for diagnosing problems. These are itemized in sections “ALIM004 printed circuit board” on page 90 and “CTRL005 printed circuit board” on page 94.

This section assumes that the instrument has powered up and one or more components are not functioning at all (e.g. the instrument powered up but the pressure sensor is not working) or not working properly (e.g. the temperature reading is not correct).

| Problem | Action | Comments |
|---|---|---|
| Display is not lit | • Check fuse F6 on ALIM004 board | |
| Keyboard does not Function | • Switch off and on the detector | The keyboard is blocked intentionally, while the detector is controlled externally via a RS 232 connection. |
| | • Replace the keyboard | |
| Light source is not lit | • Press  on keyboard | |

| Problem | Action | Comments |
|---|---|---|
| Keyboard led is ON but no stray light is observed at gain 12 | • Check fuse F5 on ALIM004 board | |
| | • Check whether LED6 on ALIM004 is lit. | |
| | • Check with a voltmeter that voltage reaches the connector near the light source on the optical head | |
| | • Replace the light source | |
| Temperature display indicates ERROR | • Check +12VDC at test point PT39 on CTRL005 board | . |
| | • Check that JP101 connector is correctly plugged | |
| | • Replace the heating tube G4218-6002x for the correct regional voltage. | |
| Pressure display is always 0 or abnormally high value. | • Check external gas line pressure | See "Pressure troubleshooting" on page 89 |
| | • Make sure the gas line is opened | |
| | • Check detector gas valve is opened | |
| | • Check +5VDC voltage at test point PT37 on CTRL005 board | |
| | • Replace the control board CTRL005 with the pressure sensor | See "Replacing the control board CTRL005" on page 137 |

| Problem | Action | Comments |
|---|---|---|
| Pressure display indicates ERROR | • Check +5VDC voltage at test point PT37 on CTRL005 board | |
| | • Replace the control board CTRL005 with the pressure sensor | See "Replacing the control board CTRL005" on page 137 |
| Pressure display is not stable | • Check external gas line | |
| | • Check glass cell siphon is filled | |
| Pressure display doesn't correspond to pressure on external manometer | • Check pressure for pressure line | See "Calibrating the pressure sensor" on page 110 |
| | • Calibrate the detector | |
| From gain 1 to gain 12, the signal doesn't change. | • Make sure you have pressed (OK) after changing the gain value | |
| | • Check light source is ON and working | |
| | • Check fuse F4 on ALIM004 board | |
| | • Check DC high voltage (should be 1000 V +/- 60 V) at J15 connectors on ALIM004 board | |

# Troubleshooting the heating unit and temperature control

## Overview

A microprocessor based temperature control provides high stability and precision. Two security stages prevent the unit from overheating. The first level (software) is provided by the microprocessor itself, and in case of trouble, a second level (hardware) is provided by a second temperature sensor, which opens physically the heating circuit in case of overheat.

## Temperature display indicates ERROR

Temperature display shows *ERROR* when the temperature value acquired by the microprocessor is not realistic. The microprocessor internal security then stops the temperature regulation, avoiding detector overheat.

The main cause for an *ERROR* message is a temperature sensor damage, or that the connector is plugged incorrectly. Then the temperature sensor must be plugged correctly or the heating unit must be replaced.

## Continuous heating

Continuous heating may be due to a problem on the CTRL005 board or the ALIM004 board.

If the heating is continuous:

- ✔ Set the temperature to the minimum value.
- ✔ If the measured temperature as indicated on the display increases or remains high, check LED1 on ALIM004 board (see Figure 17). The LED will be lit or blinking (check the blinking for at least 5 seconds as temperature regulation cycle duration is approximately 4 seconds long).
- ✔ Check LED2 on the CTRL005 board (see Figure 18).

- If LED2 is lit or blinking then the issue is due to the CTRL005 board. Refer to “If the problem is due to the CTRL005 board” on page 87
- If LED2 is not lit, the issue is due to the ALIM004 power board. Replace the board as described in “Replacing the Power Board ALIM004” on page 145.

## If the problem is due to the CTRL005 board

If the problem is due to the CTRL005 board, check the temperature displayed on the front panel and check the DC voltage at test point PT33 on the CTRL005 printed circuit board. The test point voltage must be 0.010V/°C (e.g.: 0.430V = 43°C). If the voltage and temperature displayed are correct but heating is still continuous, the board must be replaced.

The various actions on CTRL005 Board are summarized in “CTRL005 test summary” on page 87

**Table 8** CTRL005 test summary

| PT33 | PT33 | Action |
|---|---|---|
| 0 V | 0 V | Check PT41 :<br>+12 V DC: Replace board CTRL005<br>0 V : check troubles on power board voltages |
| 0 V | +12 V DC | Replace heating unit with temperature sensor |
| +12 V DC | +12 V DC | Replace heating unit with temperature sensor |
| 10m V/°C | +12 V DC | Replace board CTRL005 |

## The heater doesn't function

A lack of heating can be caused by either of the two boards.

**Table 9** Heater check table

| LED2 | LED1 | Action |
|---|---|---|
| CTRL005 Board | ALIM004 Board | • |
| Lit or blink | Doesn't light | • Check fuse F1 on ALIM004<br>• Replace board ALIM004 |
| Doesn't light | Doesn't light | • Check actual temperature at display<br>• Check whether the correct temperature has been set<br>• Switch the detector off and on again |
| Lit or blink | Lit or blink | • Switch off the detector<br>• Remove the connector CC from the power board<br>• Test the resistance of the heater (two CC pins), if infinite, replace the heating unit. |

# Pressure troubleshooting

If the pressure display does not report the correct pressure, it is most likely due to the pressure sensor. In most cases, a pressure sensor failure is due to an overpressure or humidity/liquid in the gas system. Therefore it is important to address the root cause.

- ✔ If the pressure reading is not correct, check the voltage between PT34 and PT35 on the CTRL005 board. Under normal circumstances, the voltage is 0 V when the pressure is 0 bar. If the voltage is greater than 0.1 V, replace the control board CTRL005 with the sensor, see “Replacing the control board CTRL005” on page 137.
- ✔ Raise the pressure to 3.5 bar. If the voltage is 0 V between PT34 and PT35, check PT37.
- ✔ If the voltage at PT37 is +5V, replace the control board CTRL005 with the pressure sensor (see “Replacing the control board CTRL005” on page 137).

# The printed circuit boards

The detector has two printed circuit boards. This chapter describes these boards and includes their location diagrams. In addition, it describes how troubleshooting information can be obtained from each printed circuit board.

# ALIM004 printed circuit board

The location diagram of the ALIM004 Printed Circuit Board is shown in “Location diagram - ALIM004 printed circuit board” on page 91. The fuses on this board are listed in “ALIM004 list of fuses” on page 93.

# Location diagram - ALIM004 printed circuit board

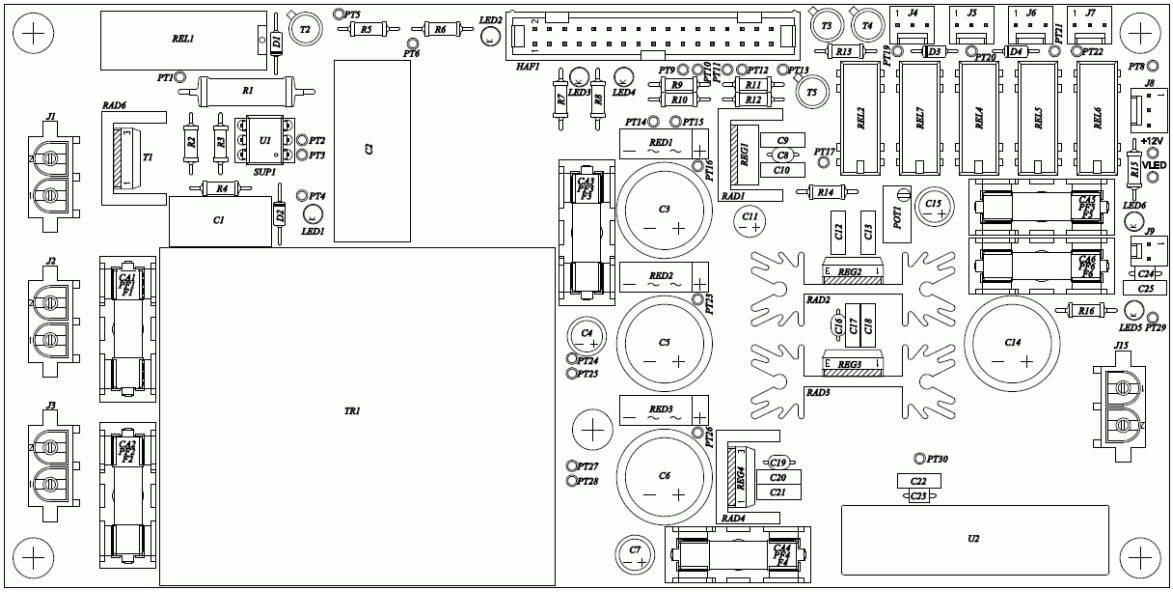



**Figure 17**

## General comments

A number of voltages on the board can be easily monitored via a corresponding LED. To determine if the voltages are present, switch on the detector, switch on light source and wait 15 minutes for voltage stabilization. The voltages indicated in Table 10 should be found on the ALIM004 board.

**Table 10** ALIM004 voltages table

| Voltage | Use | Test point | Points to check |
|---|---|---|---|
| +5 V | control board | PT8 and LED4 | • Check +5 V test point DC voltage. |
| | | | • Check fuse F6. |
| | | | • Check PT16 DC voltage (10 V). |
| +12 V | control board | +12V and LED3 | • Check +12 V test point DC voltage |
| | | | • Check fuse F3 |
| | | | • Check PT23 DC voltage (18 V) |
| +15 V | high voltage | PT29 and LED5 | • Check +15 V test point DC voltage |
| | | | • Check fuse F4 |
| | | | • Check PT26 DC voltage (24 V) |
| ~+3.5 V | high voltage | VLED and LED6 | • Check light source is ON in the menu |
| | | | • Check PT13 (must be +5 V DC) |
| | | | • Check VLED DC voltage |
| | | | • Check fuse F5 |
| | | | • Check PT17 DC voltage (12 V) |

If all voltages are missing

✔ Check main fuses (rear of the detector) and fuse F2 on the board. If all fuses are OK and fan is rotating, the transformer TR1 is the cause and the ALIM004 board needs to be exchanged.

If one of the voltages is missing outputs of the transformer can be checked on an individual basis:

- ✔ +12 V secondary : check AC voltage between PT24 and PT25
- ✔ +5 V secondary : check AC voltage between PT14 and PT15
- ✔ +15 V secondary : check AC voltage between PT28 and PT27

If the +3.5 V is missing: check on the instrument keyboard that the LED which indicates that light source is ON is lit, then check:

- ✔ PT13 must be +5 V DC. If not, check the connection cable between boards ALIM004 and CTRL005. If there is no defect, replace board CTRL005 (not: ALIM004).
- ✔ VLED must be +12 V DC. If not, replace board ALIM004.
- ✔ PT18 must be about +3.5 V DC. If it is 0V, replace the board.

**NOTE** For adjusting the voltage for VLED, please refer to section "Exchanging the light source" on page 131, steps 9 and following.

## ALIM004 list of fuses

| Fuse | | |
|---|---|---|
| main | Used in 100 V, 115 V and 230 V detectors | T3.15 AL / 230 V |
| F1 | Heating for drift tubes | T2.00 AL / 230 V |
| F2 | Internal protection-main transformer protect | F500 mAL / 230 V |
| F3 | +12 V | F500 mAL / 230V |
| F4 | +15 V for high voltage module | F500 mAL / 230 V |
| F5 | +3.6 V for light source | F500 mAL / 230 V |
| F6 | +5 V | F500 mAL / 230 V |

# CTRL005 printed circuit board

The CTRL board is used for temperature regulation, pressure acquisition, signal acquisition and processing and the keyboard and display interface.

The location diagram of the CTRL005 Printed Circuit Board is shown in section “Location diagram - CTRL005 circuit board” on page 94.

## Location diagram - CTRL005 circuit board

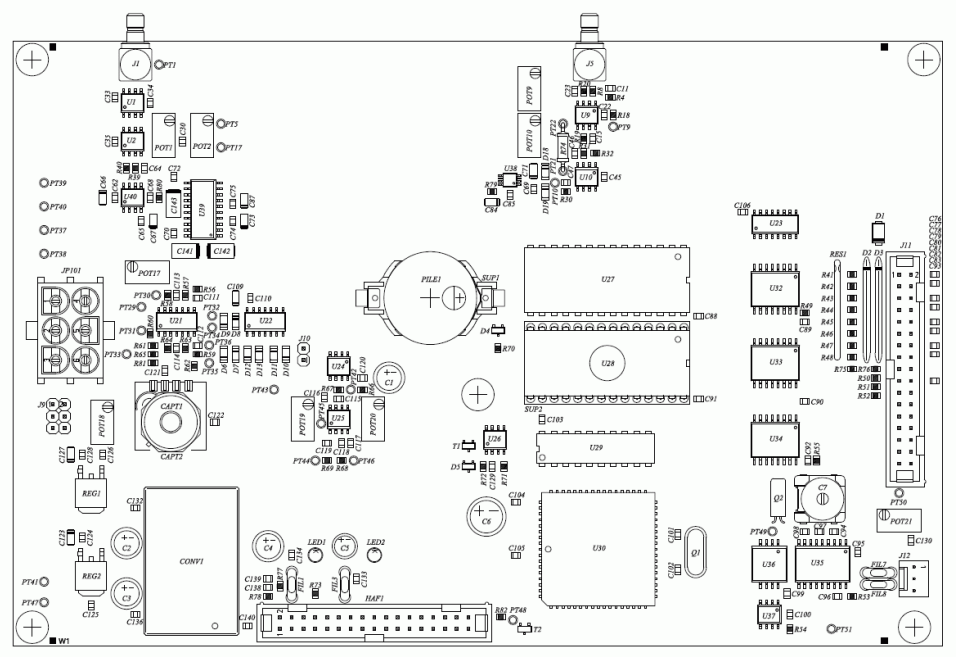


**Figure 18**

## General comments

To determine if the voltages are present, switch on the detector, switch on light source and wait 15 minutes for voltage stabilization. The voltages indicated in Table 11 should be found on the CTRL005 board.

**Table 11** CTRL005 voltages table

| Voltage | Use | Test point | Points to check |
|---|---|---|---|
| +5 V | amplifiers | PT37 | • Check *+12 V* at PT41 |
| -5 V | amplifiers | PT38 | • Check *+12 V* at PT41 |
| +12 V | amplifiers | PT39 | • Check *+12 V* at PT41 |
| -12 V | amplifiers | PT40 | • Check *+12 V* at PT41 |
| +12 V | DC converter | PT41 | • Check *+12 V* on ALIM004 at +12V |
| +5 V | numeric | PT47 | • Check *+5 V* on ALIM004 at PT8 |

# 7 Maintenance



This chapter describes:

- The maintenance procedures that should be performed by the operator on a routine basis (see "General inspection" on page 98).
- Cleaning and decontamination procedures that should be performed to maintain instrument performance (see "Cleaning and Decontamination" on page 99).

# General inspection

The Agilent 1200 Series Evaporative Light Scattering detector is designed for a low level of maintenance activities. Maintenance activities are normally the responsibilities of the user. If preventive maintenance activities are followed, the system provides high sensitivity measurements without intervention of the operator.

- ✔ Ensure that the detector is installed according to the site requirements (see "Site Requirements" on page 22) in a clean laboratory environment, away from sources of heat or ventilation.
- ✔ Make sure that the detector exhaust is vented to a fume hood or lab exhaust line.
- ✔ Check that the detector is kept clean. There should be no foreign material on the joints, in the nebulizer, the glass tube, etc.
- ✔ Make sure the siphon of the nebulization chamber is filled with solvent. Ensure that the gas flow does no bubble through the siphon and the liquid level is not fluctuating. If this should be the case, check for a correct installation of the exhaust tube and make sure the vacuum applied there is neither to strong nor to weak.
- ✔ Check the nebulizer. The flow from the nebulizer should be fine and homogeneous. If it is not, the nebulizer, the needle or the Teflon tube may be obstructed with foreign material. Clean the nebulizer as described in "Cleaning the Nebulizer" on page 103.
- ✔ All tubing should be in good shape. Any damaged tubing or tubing with kinks should be replaced.
- ✔ All cables should be in good shape. Any electrical cables that are frayed or damaged should be replaced.
- ✔ Only use filtered oil-free pressurized gas.

# Cleaning and Decontamination

## Cleaning the Detector

**WARNING**

***Shock hazard and damage of detector***

**Liquid drip into the detector could cause shock hazard and damage the detector.**

=> Do not let liquid drip into the detector

1 Turn the instrument off.

2 Unplug all connection cables, the gas input and nebulizer tubing before cleaning.

3 If the unit has been powered up, wait for it to cool down before proceeding.

4 Clean the instrument with a clean, non-abrasive rag. If necessary, a solvent such as isopropanol can be used.

## Decontaminating the detector

**WARNING**

***Health risk by potentially harmful substances***

**The toxicological properties of many samples separated by the HPLC system are usually not well known. They could cause toxications and other health risks.**

=> If you have any doubt about the cleanliness of a detector, treat the detector as if it contained a potentially harmful substance and decontaminate it before working on it.

To decontaminate the detector:

1. Power up the detector and allow nebulizer gas to flow through it in the normal manner.
2. Deliver a mobile phase that will dissolve the contaminant at a flow rate of 1 ml/min. If you do not know what the contaminant is, ethanol or acetone are good choices.
3. Access the temperature adjustment mode via the control panel.
4. Push and hold the ⊕ button for 5 s. This will automatically set the temperature to 100°C (you may also set the desired temperature using the instrument keyboard or user interface).
5. Maintain the flow and temperature for at least 3 hours.
6. Clean the exterior of the detector with a rag saturated with isopropanole.

# Customer Service Procedures

## Removing the nebulization chamber and nebulizer

If the nebulizer shall be stored afterwards, please flush the nebulizer and shut down the system as described in “Powering Down and Shutting Down the System” on page 58.

1 Turn off the LC pump or any other mobile phase flow.

2 Turn off the ELS detector.

3 Stop the gas flow using the external pressure regulator.


**Figure 19** Replacing the nebulization chamber

For subsequent steps, see Figure 19.

**4** Remove the capillary connection to the mobile phase

**5** Remove the connection to pressurized gas by pushing on the white inlet (see arrow).

**6** Remove the drain tube.

7 Remove the small black plastic nut at the rear and carefully lift out the nebulization chamber.

8 Remove the large black plastic nut at the top and remove the nebulizer.

If you want to store the nebulizer, clean the nebulizer as described in "Cleaning the Nebulizer" on page 103 and protect all openings using Parafilm™ or similar polymer foils.

For re-installing the nebulizer or replacing it by a new one or different type, reverse the order of previous steps as described in "Installing the Nebulizer and Nebulization Chamber Assembly" on page 45. In case the black gas tubing has been removed, make sure you are using the correct orientation, where the white filter is at the lower end. Avoid leaks at all connections and check for leakages when you turn on the pump again.

**CAUTION**

*Damage of flow cells.*

When using the ELSD with another detector, using a flow cell which is not compatible with the back pressure generated by the chosen ELSD nebulizer can destroy the flow cell.

=> See Table 13 for nebulizer back pressures and compare them to the specifications of your flow cell.

## Cleaning the Nebulizer

**WARNING**

***Damage of the nebulizer***

**Improper handling of the nebulizer can damage the part.**

=> Handle the nebulizer with care and do not disassemble the rear part of the nebulizer, which is protected by the colored thermal seal.

**To remove the nebulizer from the system:**

1 Turn off the HPLC system.

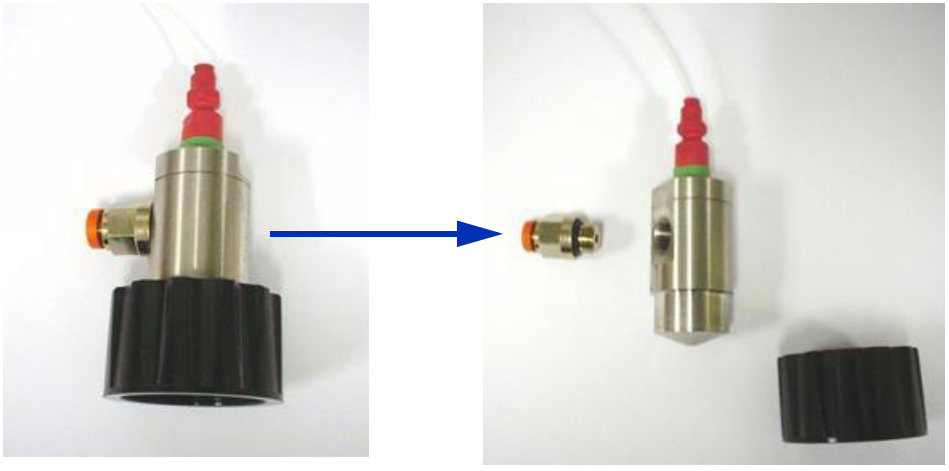
2 Disconnect the nebulizer liquid inlet from the column.

3 Disconnect the gas inlet from the nebulizer.

4 Remove the nebulizer from the detector, taking care to never pull on the rear connection tubing.

5 Remove the nebulizer black nut and seal.

6 Remove the gas inlet quick fitting.



**To clean the nebulizer:**

1 Fill an ultrasonic bath with approximately 2 cm of the appropriate solvent, which depends on the nature of the material that is present in the nebulizer. In most cases, ethanol is a satisfactory solvent.

2 Place the nebulizer vertically in the solvent bath. The nebulizer outlet should be placed at the bottom.


3 Clean the nebulizer for approximately 30 minutes with the solvent, and then replace the solvent with water and clean for an additional 30 minutes.

### To fix up the nebulizer:

1 Fix the gas inlet fitting on the nebulizer (see "Installing the Nebulizer and Nebulization Chamber Assembly" on page 45).

2 Fix the nebulizer on the nebulization chamber.

3 Test the nebulizer to ensure that it is working properly.

If the performance cannot be improved by cleaning the nebulizer, a new nebulizer might be required.

# Adjusting signal intensities after a nebulizer exchange

The nebulizer can be changed as described in "Removing the nebulization chamber and nebulizer" on page 101.

When a new nebulizer is installed in the detector, the signal from a given sample may be slightly different from the signal that was obtained using the old nebulizer.

As quantitation is based on peak areas and therefore on the signal height, after replacing the nebulizer new calibration curves need to be measured, which translate peak areas into concentrations. In some cases, it might be required that not only resulting concentrations are equal but also peak areas. In such a case the signal intensity can be adjusted in two ways:

- either on a software level by setting the value for the light source normalization (see "The Digital Display" on page 159) or
- on the electronic level by adjusting the potentiometer on the control board.

The first setting is easily accessible to customers, while the second option should be chosen for bringing the instrument to a default factory mode, where there is no signal level scaling factor for option 1, i.e. the value is 100%.

So the second option is only required in special cases and should not be considered as a standard procedure required for troubleshooting. This procedure is not part of the preventive maintenance service or any other replacement of the LED, but would need to be purchased as a consulting service.

Applying this procedure requires, that standardized conditions have been defined, for which peak heights have been measured and documented, e.g. conditions which are used for the checkout sample or compliance procedures.

1. Stop the HPLC.
2. Turn off the gas flow (this can be done from the detector menu controlling the internal gas valve).
3. Remove the old nebulizer as described in "Removing the nebulization chamber and nebulizer" on page 101 and place the new nebulizer in position.
4. Open the gas valve and check the pressure is set to 3.50 bar.

5 Set the conditions you have used for measuring the reference data (read above) and run 6 injections using these conditions.

6 Adjust the potentiometer POT10 on control board CTRL005, (see Figure 20) to obtain the same result (average peak height on 6 injections) as from the reference measurements prior to the nebulizer exchange

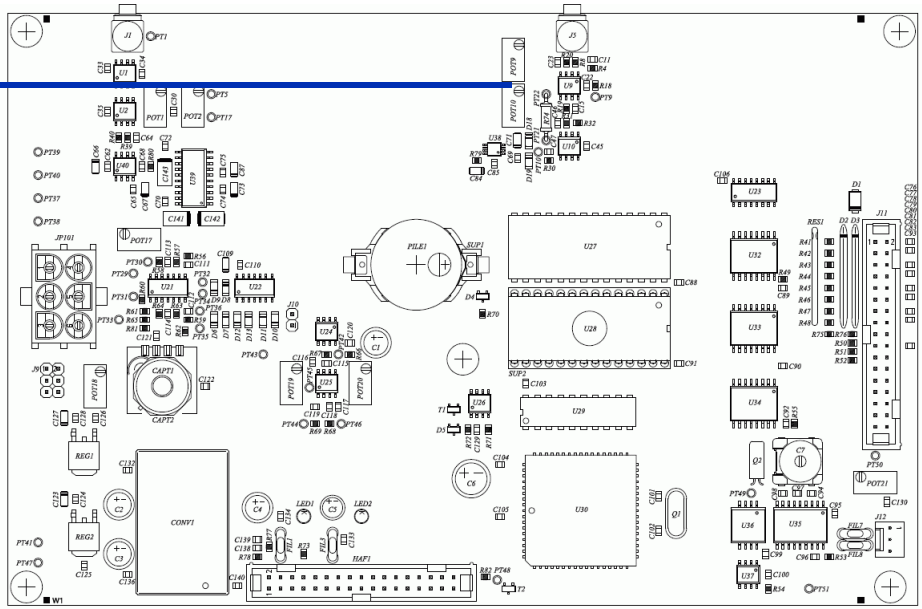



**Figure 20** Location of POT10 on Control Board

**NOTE** Adjusting the potentiometer will also affect the measurement results for the stray light test of the detector.

# Adjusting the stray light settings

## Preparing the detector

1 Switch off the detector.

2 Remove the detector cover.

3 Ensure that the nebulizer and nebulization chamber are installed correctly.

4 Ensure that the siphon of the nebulization chamber is filled as shown in Figure 21.


**Figure 21**

5 Switch on the detector.

6 Ensure that the gas pressure is 3.5 bar.

7 Switch on the light source by pressing button .

8 Wait at least 15 minutes for the temperature stabilization.

# Stray light setting

1. Set gain 1.
2. Perform an autozero (make sure the setting "offset after autozero" is 0 mV).
3. Set gain 12.
4. Pump water at a flow of 1 ml/min until the signal becomes stable.
5. Switch off the pump. The value of signal obtained is the stray light.
6. Adjust trimmer POT10 on board CTRL005 to obtain the desired stray light, which is the one of a previous reference measurement.

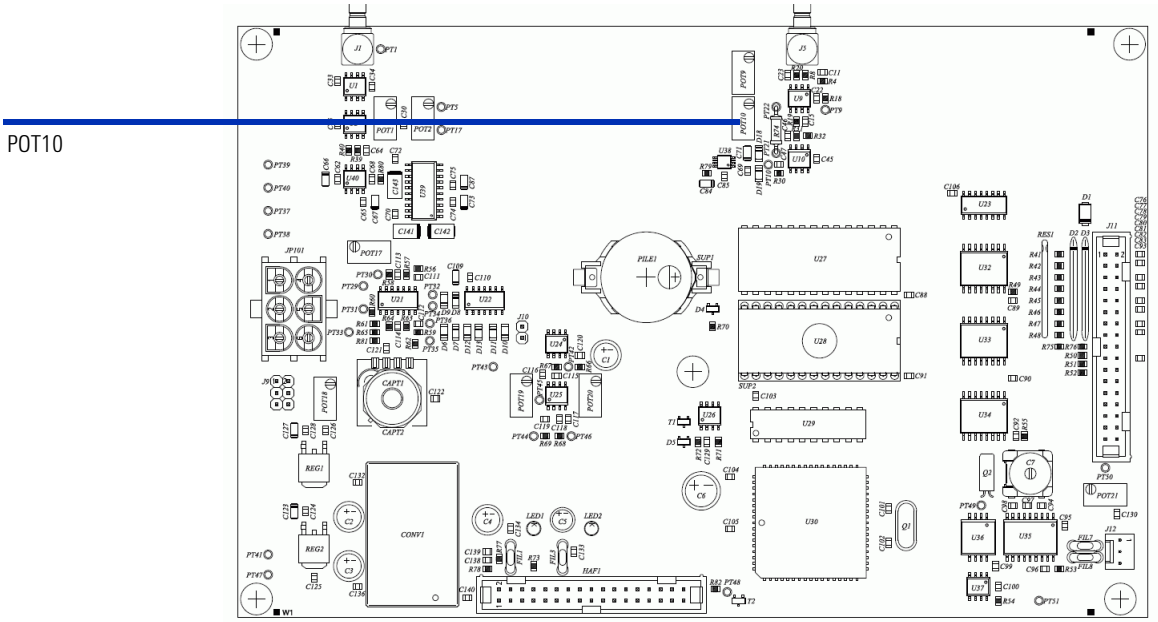



**Figure 22**

# Calibrating the pressure sensor

This operation can be performed when some drift of the measured pressure is observed. This drift can only be measured with a precise and certified calibrated external manometer. The effect of small deviations from the correct pressure on the measurement result is small. So this is no part of the PM service or any standard repair.

1 Switch on the detector.

2 Use the instrument keyboard for opening the gas valve.

3 On the instrument keyboard, enter the factory menu.

4 Set the factory code with arrows and ⊕ and ⊖ then press OK to access factory menus.

5 Check that no gas is entering the detector.

6 Navigate downwards to menu SET PRESSURE TO 0 BAR.

7 Press OK button.

8 With a certified calibrated external manometer (0 to 4 bar full scale, precision 0.1 bar, see product support plan for recommended tools), set the pressure precisely to 4.0 bar. The more accurate you set this pressure for the calibration, the more accurate the detector will be.

9 Select the SET PRESSURE TO 4 BAR menu.

10 Press OK button.

11 Navigate upwards in the menus to the initial status display.

**NOTE**

For setting a pressure on a calibrated manometer, take care of the hysteresis effect (see manometer manufacturer instructions for more details).
Please, always set the 4 bars pressure by increasing.
Example :
Incorrect : Increase pressure to 4.1 then decrease to 4.0 bars.
Correct : Increase pressure to 3.9 then increase slowly to 4.0 bars.

**NOTE**

When using the external manometer, make sure to use the instrument orientation specified by the manufacturer. Some manometers must be used either horizontally or vertically, otherwise an error of up to 0.1 bar could be observed. Please refer to manufacturer instructions.

# Full scale signal adjustment (0 and 1100 mV)

This procedure can be used for re-adjusting the external signal output to the signal display on the keyboard. For example, if the signal measured for the output of the signal cable is 126 mV while the displays shows 123 mV, use to the following procedure to make the adjustment.

A DC Voltmeter with 0.1 mV resolution is needed for this procedure.

1. Switch off the detector.
2. Unplug the the signal cable connected to the acquisition system.
3. Connect the voltmeter to the signal cable output.
4. Switch on the voltmeter.
5. Switch on the detector and wait for temperature stabilization.
6. Navigate to the factory code menu.
7. Navigate to the menu "Set signal output 0 mV".
8. Press OK.
9. A message appears: Adjust Trimmer Pot1.
10. Adjust trimmer Pot1 on control board CTRL005 such that 0.0 mV are measured by the voltmeter.
11. Navigate to the menu Set signal output 1100 mV.
12. Press OK.
13. A message appears: Adjust Trimmer Pot2.
14. Adjust trimmer Pot2 on control board CTRL005 such that 1100 mV are measured by the voltmeter.
15. Setting is finished.

    For checking this setting:

    1. Navigate to the status menu (top menu).
    2. Switch off the light source.
    3. Set gain 1, press autozero.
    4. Verify that the voltmeter shows 0 mV.
    5. Switch on the light source.

6 Set gain 12.

7 Check that display and voltmeter are the same within +/-1 mV tolerance.

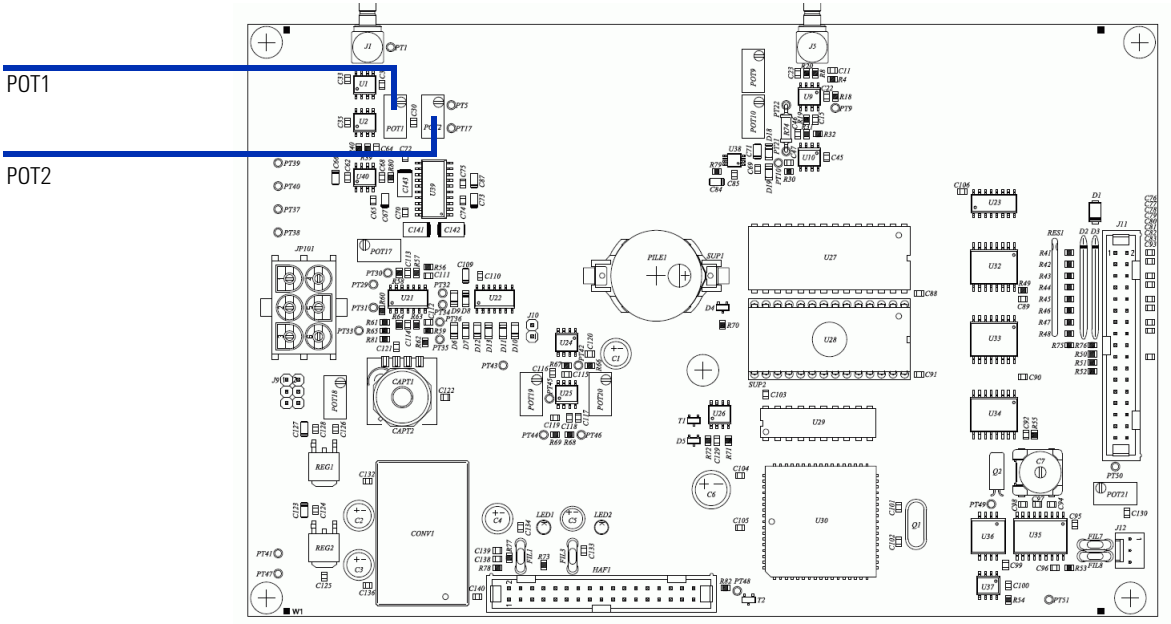



**Figure 23**

# 8
# Repairs

# Internal Service Procedures

## Opening the instrument

1 Remove 9 cross-head screws. There are 7 screws at the rear and two at the sides. Push the cover to the back, then lift it up.

2 For reinstalling the cover, insert it carefully to the slits of the front panel. Use the top middle screw at the rear and both screws at the side for fixing it at the correct position, before fixing all other screws.

## Removing the front panel

1 Remove the nebulization chamber and nebulizer as described in “Removing the nebulization chamber and nebulizer” on page 101.

2 Remove the instrument cover as described in “Opening the instrument” on page 116.

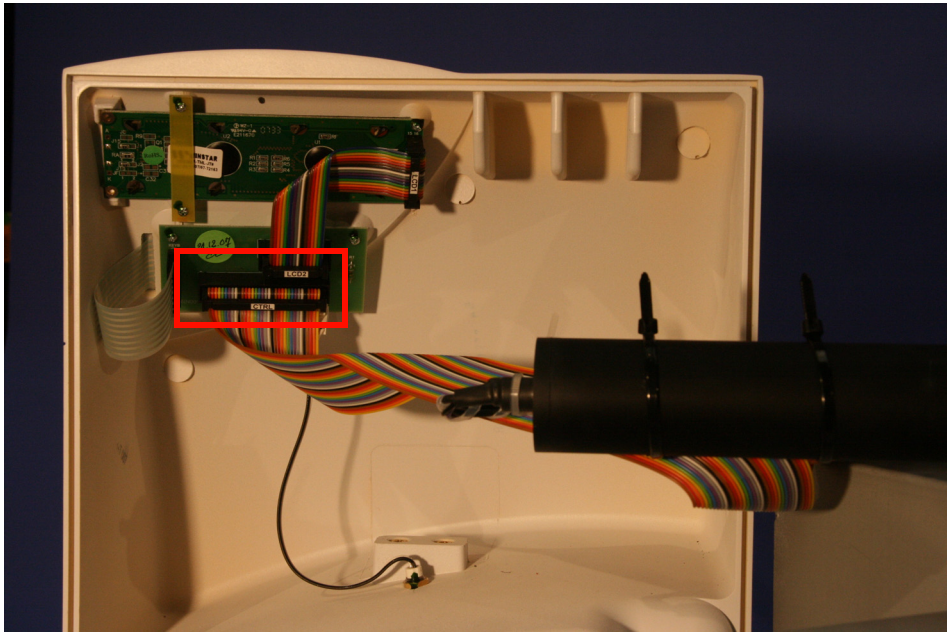


**Figure 24** Removing the control cable of the front panel

**3** Remove the control cable "CTRL" of the front panel from the socked of the front panel as shown in Figure 24.

**Figure 25**

4 Remove the tube for pressurized nitrogen, which is connected to the front panel at the left bottom corner of the instrument.

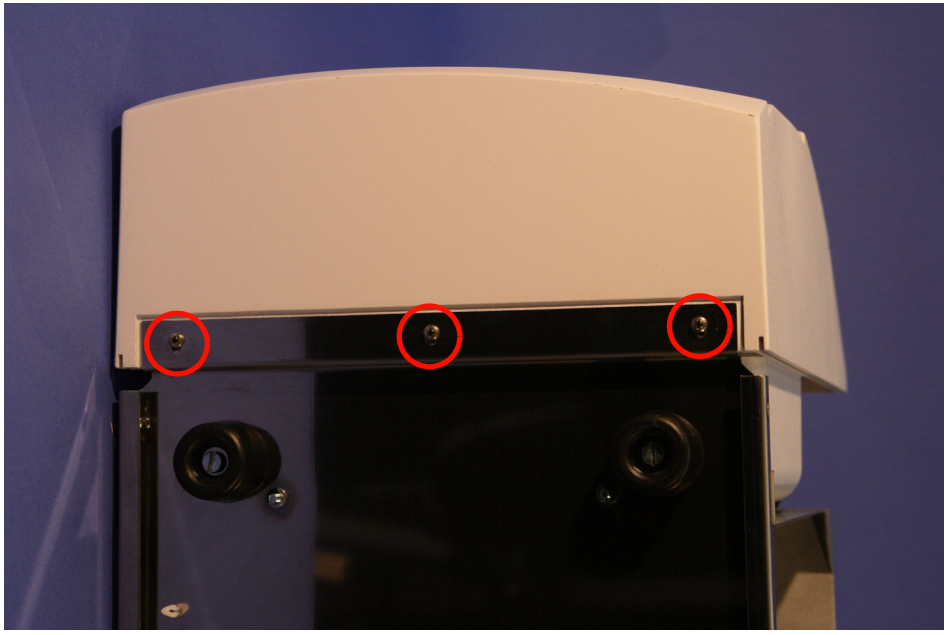


**Figure 26** Removing screws at the bottom of the front panel

**5** Remove 3 cross-head screws at the bottom of the instrument.

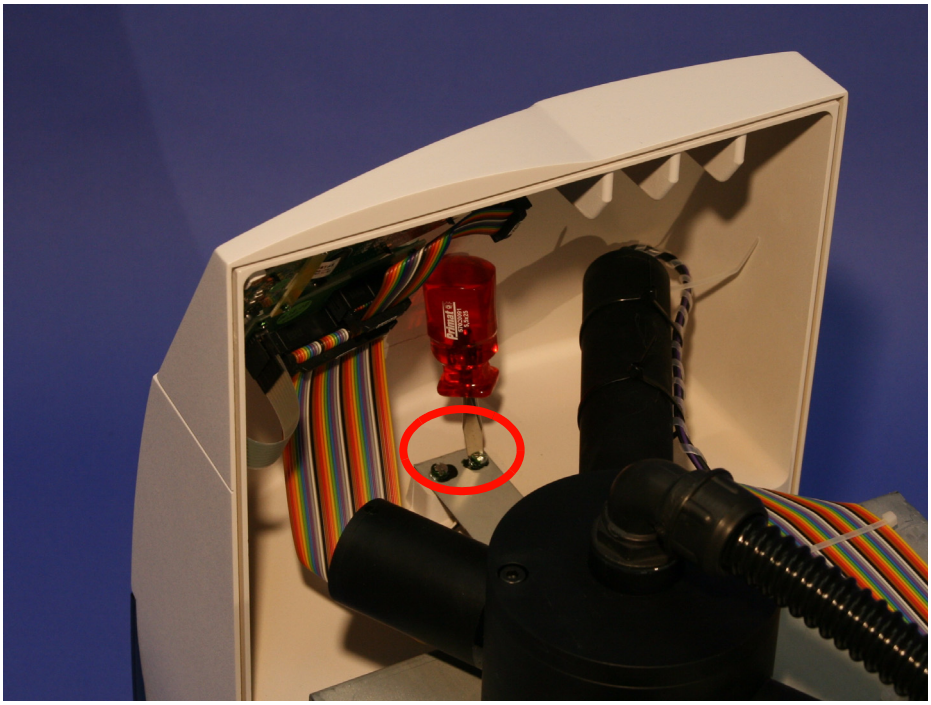


**Figure 27** Removing screws fixing the front panel

**6** Use a short screw driver for removing two cross-head screws fixing the front panel to the instrument chassis.

# Removing the heating unit

**WARNING**

***Risk of Burn***

**Internal parts, especially the heating unit, become very hot (100 °C, 210 F) during operation.**

=> Allow to cool down these parts before opening the instrument and accessing these parts.

1 Remove the nebulization chamber as described in “Removing the nebulization chamber and nebulizer” on page 101.

2 Open the detector cover as described in “Opening the instrument” on page 116.

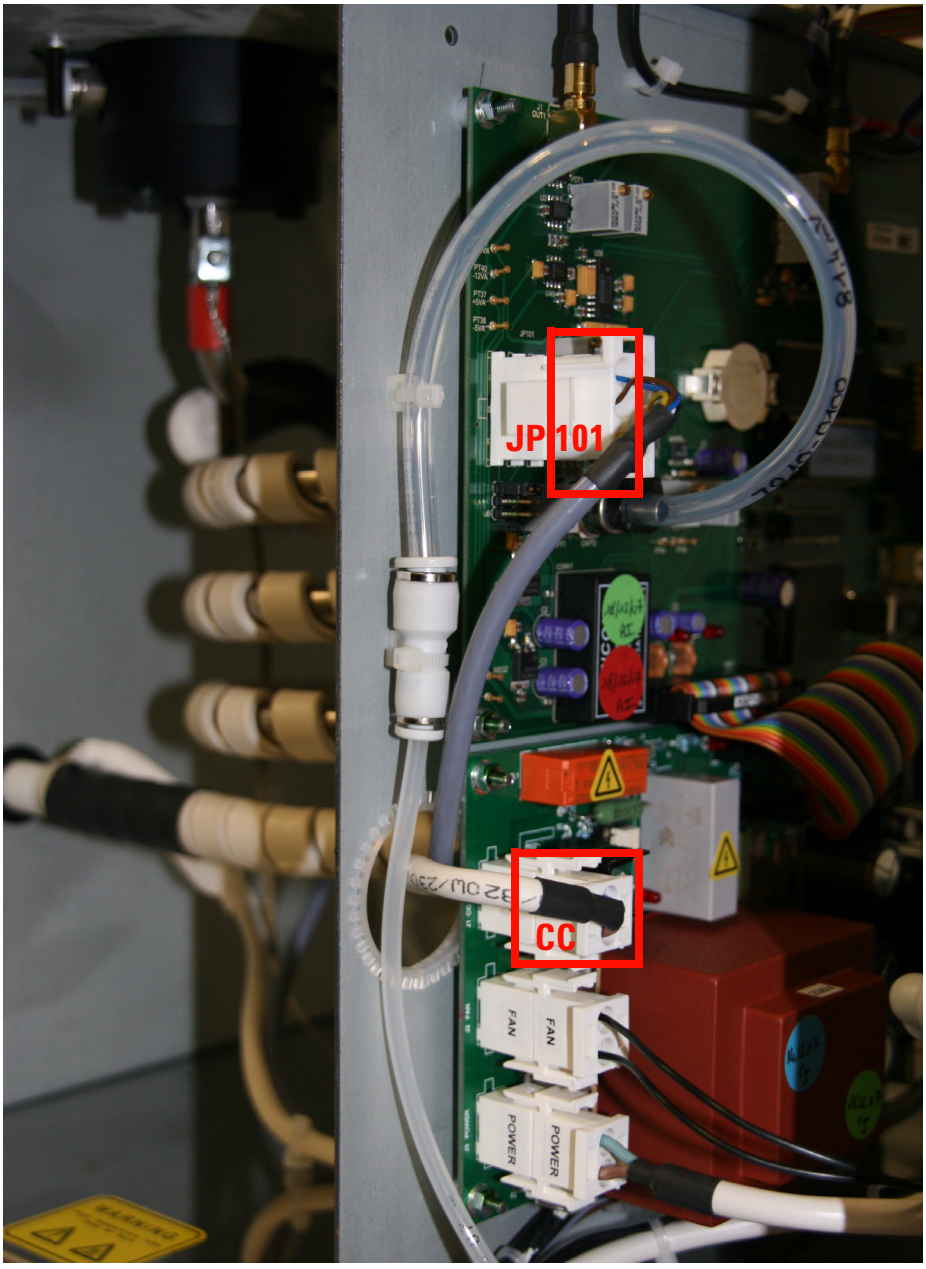



**Figure 28** Removing connectors from the boards

3 Remove the connector labeled with CC (power cable) from the lower power board ALIM. Remove the connector labeled with JP101 (temperature sensor) from the upper control board CTRL.

4 Cut the ty-raps, which fix the cables to the pegs. Do not cut the pegs, which fix the ty-raps to the instrument chassis.

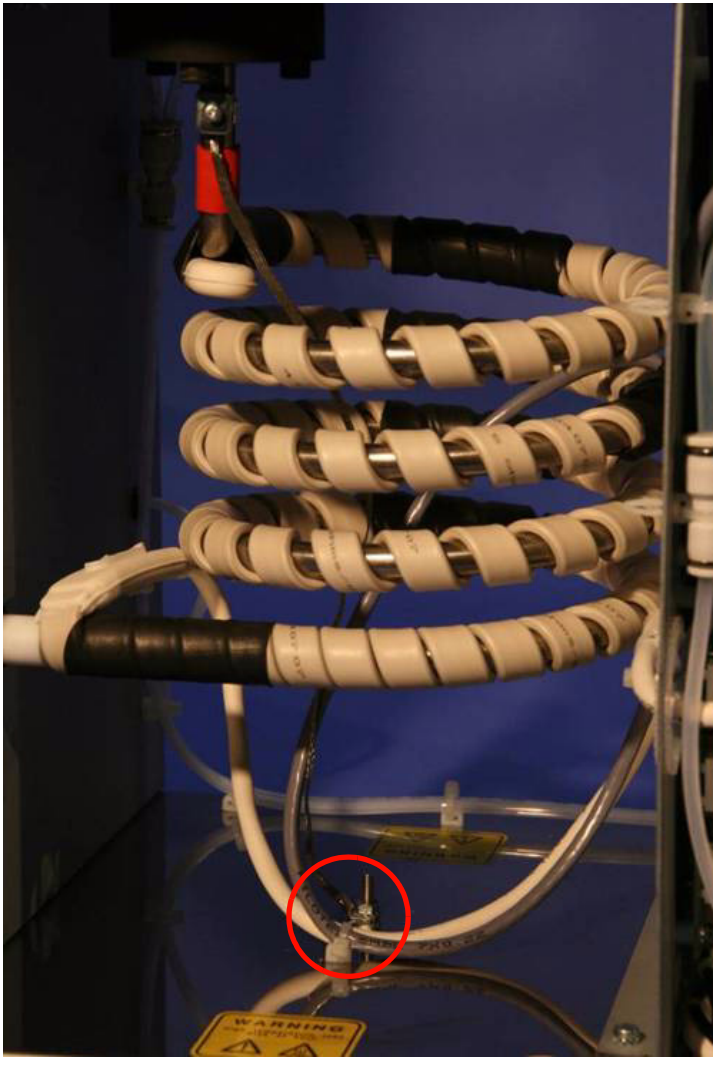


**Figure 29** Removing the grounding cable

5 Use a 7 mm hex wrench for removing the screw at the bottom of the instrument, which connects the grounding cable of the heating unit.

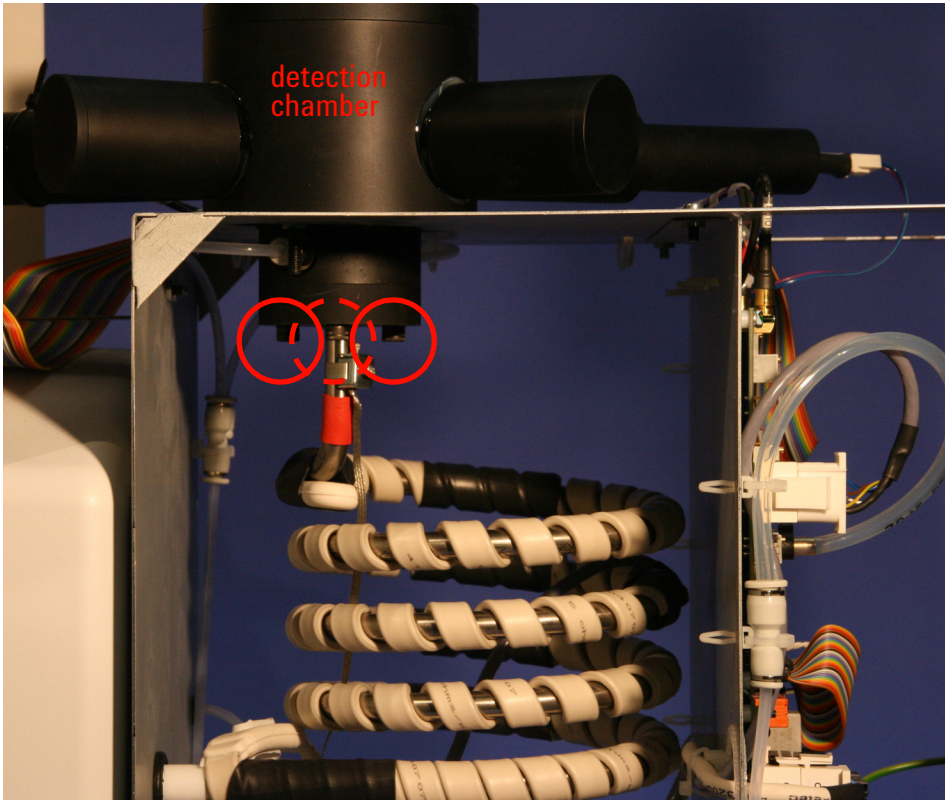



**Figure 30**

6 Open three 4 mm hex screws, which fix the heating unit to the detection chamber.

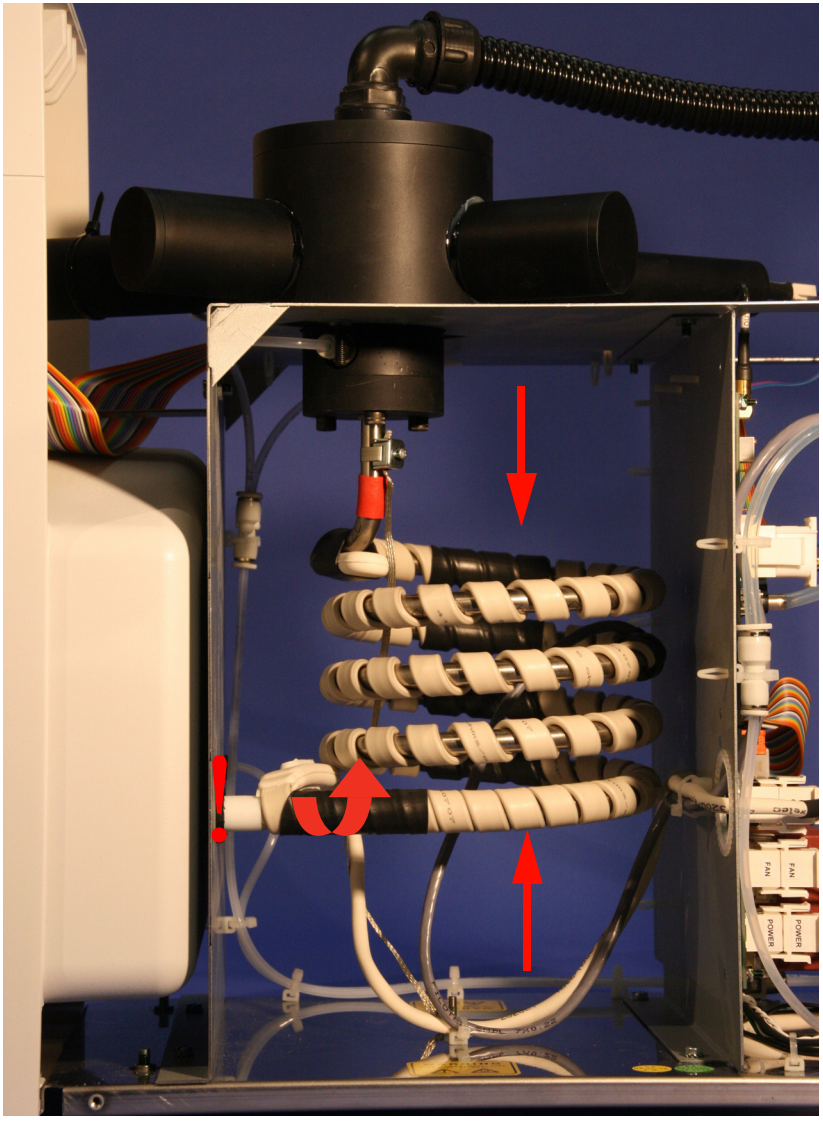



**Figure 31**

7 **Gently** squeeze the spiral of heating spiral such the heating unit can be removed from the detector chamber. Then carefully twist the unit out of the front panel to the back of the instrument.

## Removing the detection cell

1 Remove the nebulization chamber and the front panel, see “Removing the nebulization chamber and nebulizer” on page 101.

2 Remove the front panel, see “Removing the front panel” on page 116.

3 Remove the LED, see “Exchanging the light source” on page 131.

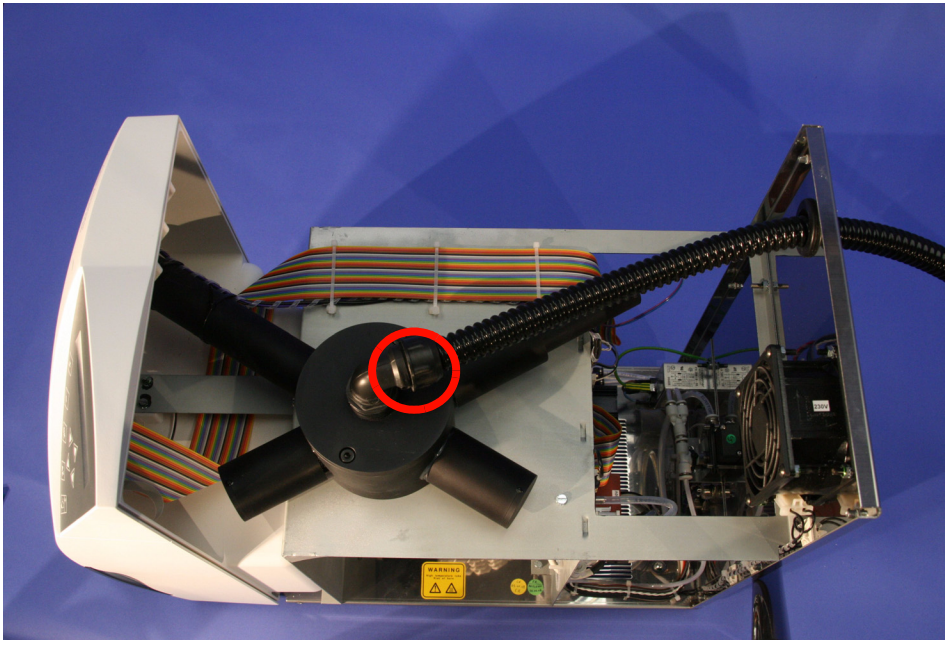


**Figure 32**

4 Remove the black exhaust tube.

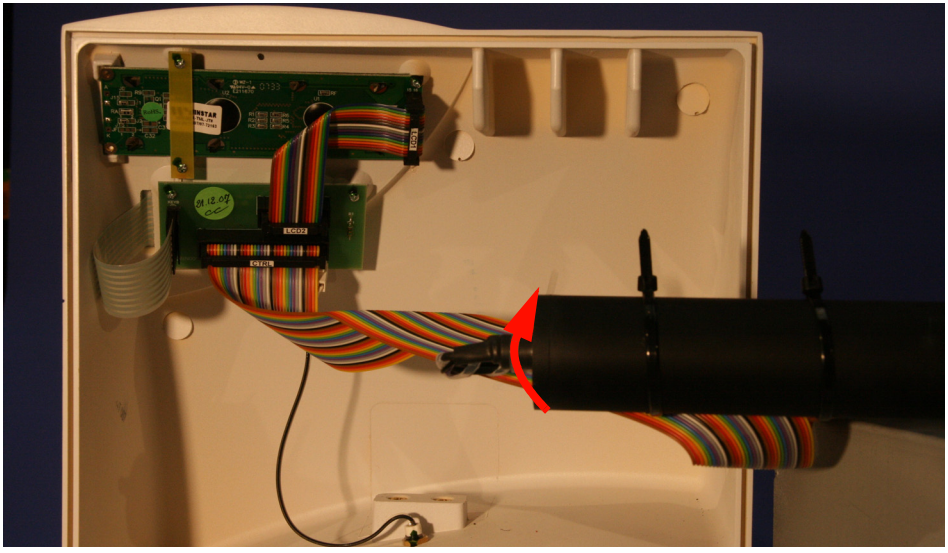


**Figure 33**

**5** Unscrew the photomultiplier. If necessary cut the ty-raps, which fix the photomultiplier cable to the detection chamber and instrument chassis.

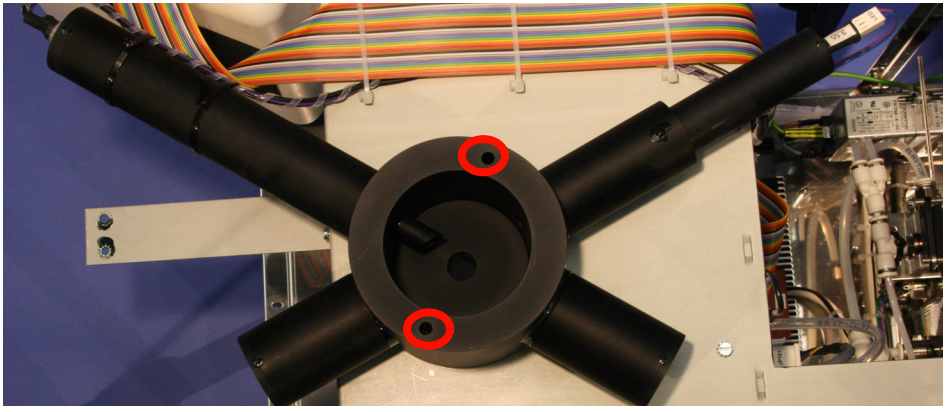


**Figure 34**

**6** Remove the two black hex screws at the top of the detection chamber and lift up the lid of the detection chamber.

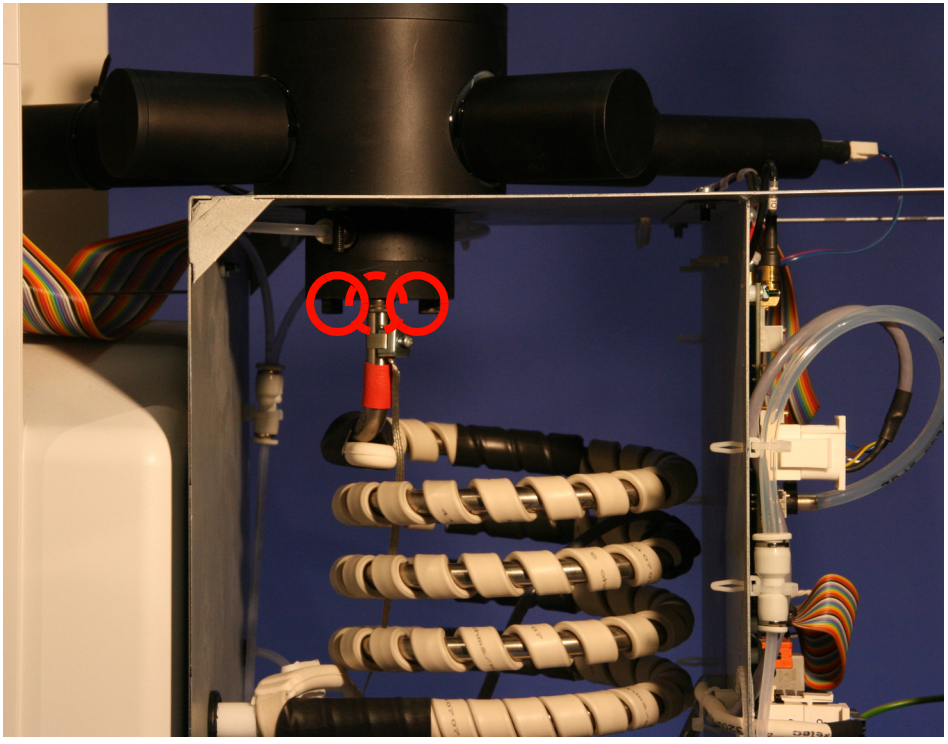


**Figure 35**

7 Open three 4 mm hex screws, which fix the heating unit to the detection chamber.

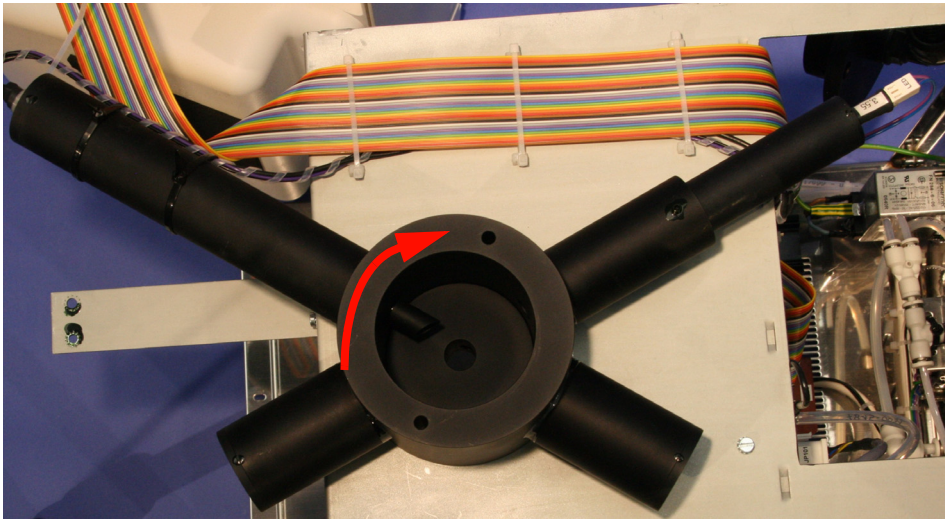


**Figure 36**

**8** Clockwise rotate the detector chamber, then lift it to the top.

# Exchanging Internal Parts

The procedures in this section describe how to exchange defective internal parts.

## Warnings and Cautions

**WARNING**

***Electrical hazard***

**Some internal parts like the power supply or the supply of the photo-multiplier carry a high voltage. Touching these parts while the power is on exposes you to a danger of life.**

=> Whenever possible, turn off the instrument and remove the power cord from the instrument.

---

**WARNING**

***Risk of Burn***

**Internal parts, especially the heating unit, become very hot (100 °C, 210 F) during operation.**

=> Allow to cool down these parts before opening the instrument and accessing these parts.

---

# Exchanging the light source

1 Switch off the detector.
2 Remove the detector cover.
3 Disconnect the light source connector (see Figure 37, step 1).
4 Unscrew the light source cap (see Figure 37, step 2).

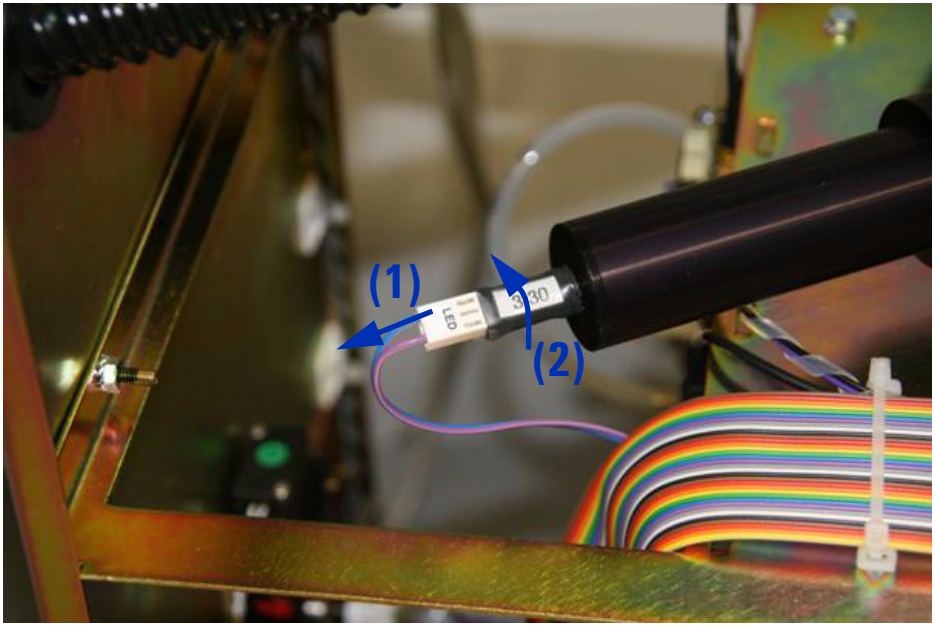



**Figure 37** The Light Source Connector and Cap

5 Screw the new light source cap.

**NOTE** Do NOT plug in the light source connector now.

6 Switch on the detector.

7 Switch on the lamp by pressing the button.

8 Check the voltage at test point VLED on board ALIM004 (see Figure 38). The ground should be one of the fixing screws that attach the board to the detector.

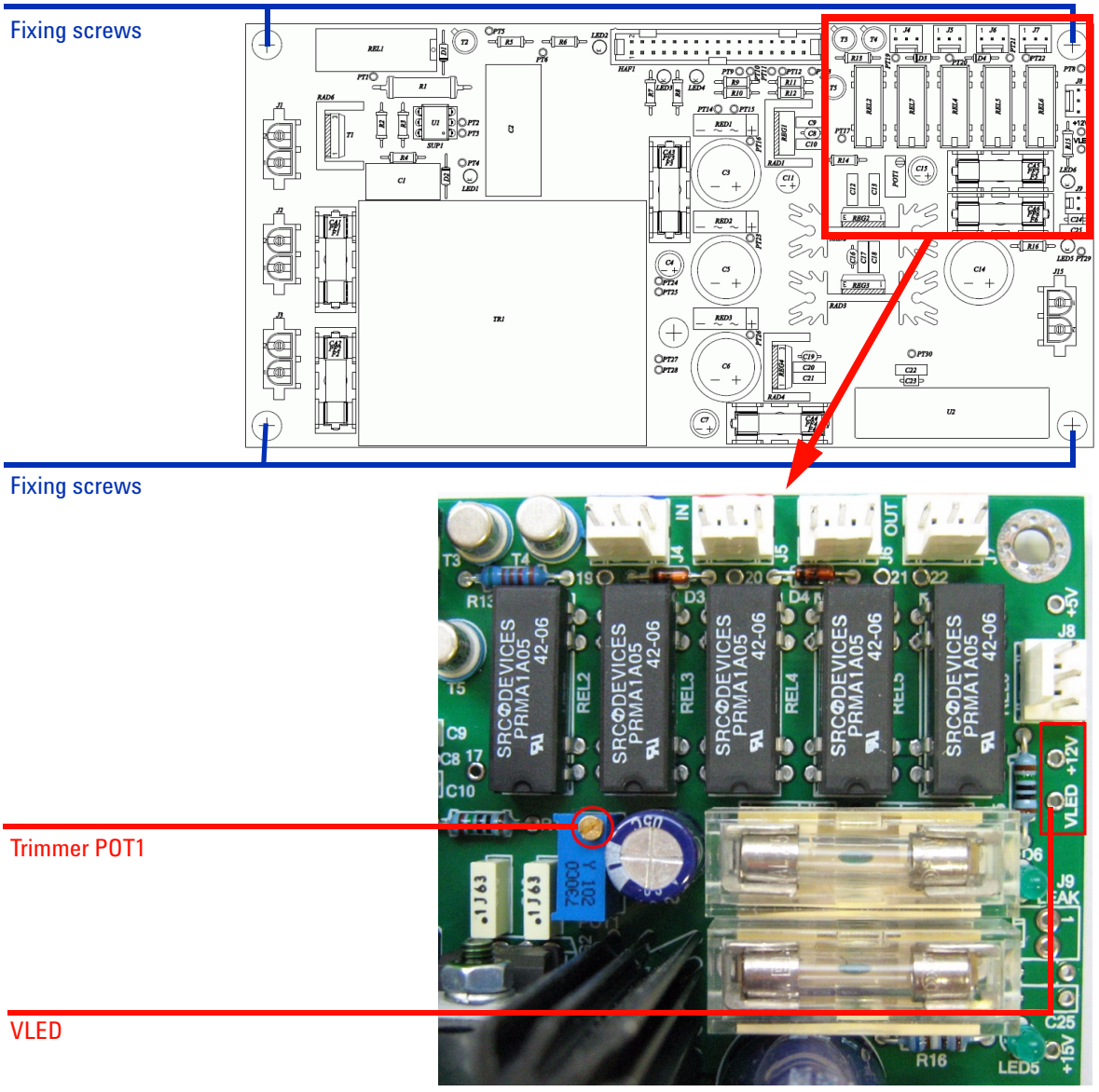



**Figure 38** The ALIM004 Board and Trimmer POT1 and test point VLED magnification

9 The voltage at VLED must be set to the value that is provided with the new LED with a precision of 2 digits (example: + 3.30 V, see Figure 38). If the voltage is incorrect, adjust it with trimmer POT1.

10 Switch off the light source

11 Plug in the light source connector.

12 Switch on light source and equilibrate for 5 minutes.

13 Check, whether the voltage is stable after equilibration. If necessary, adjust the voltage at trimmer POT1.

**CAUTION**

*Lifetime of LED and quality of measurement results*

Wrong potential decreases lifetime of LED and decreases quality of measurement results

=> Set potential accurately.

14 In the LED *menu* of the control panel, access the "Reset lifetime" line and press OK to reset the elapsed time counter for the LED.

15 If a normalized light intensity is required, this setting can be adjusted after 15 minutes of equilibration using the instrument keyboard, see "The Light source Normalization Screen" on page 164

# Exchanging the gas valve

1. Switch off the detector,
2. Unplug the main power cord
3. Open the detector cover.
4. Unplug the gas valve electrical connector J7 on the power board.
5. Remove the ty-raps which fix the cable in the detector.
6. Unplug the 2 gas outlet tubings from the gas valve T-connector.
7. Unplug the gas inlet tubing from the gas valve body.
8. Remove the ty-raps which fix the gas valve to the detector body

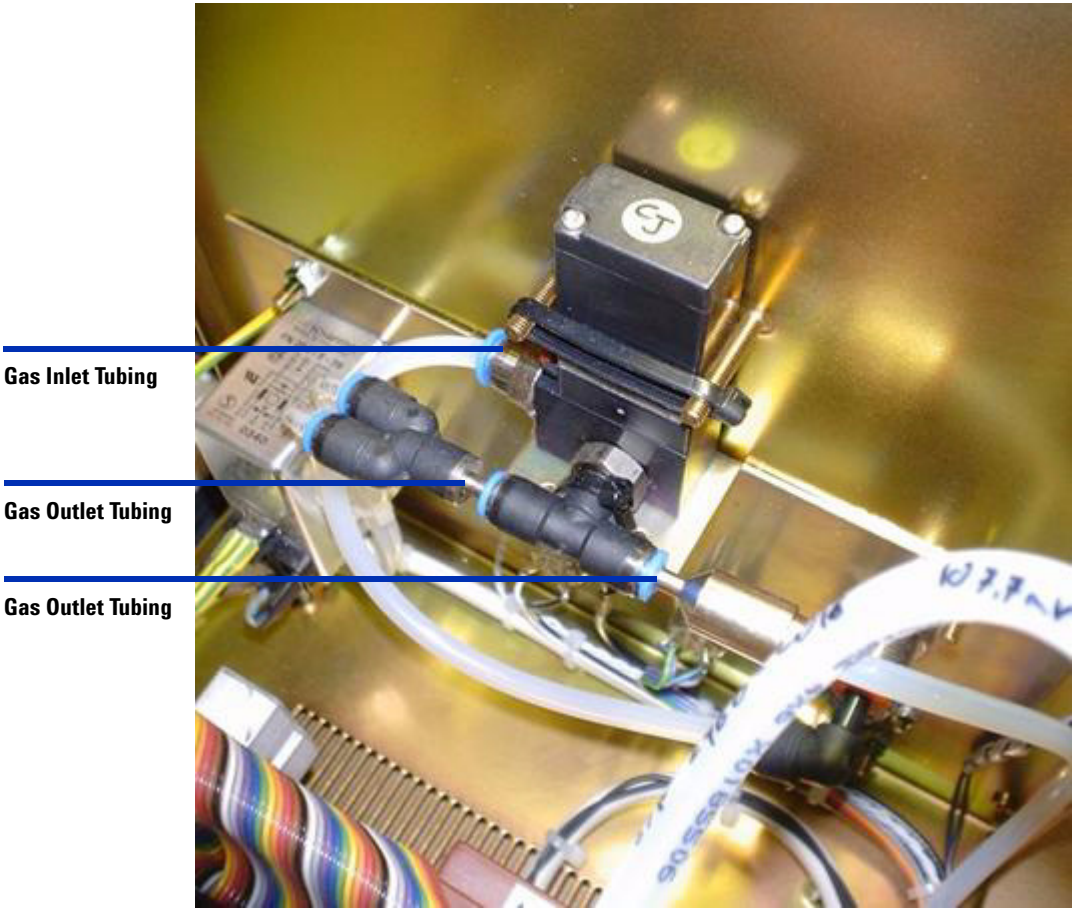



**Figure 39** Exchanging the gas valve

**9** Place the new gas valve and fix it to the detector body.

**10** Connect the 2 gas tubings.

**11** Connect the connector J7 to the power board taking care that the cable follows the same path.

**12** Use ty-raps to fix properly the cable.

# Replacing the control board CTRL005

CTRL005 board does not depend on main power voltage, i.e. there is only one board type regardless of regional voltages.

1 Unplug connectors, which are marked red in Figure 41.

2 Remove the pressure sensor tubing from the detector gas line.

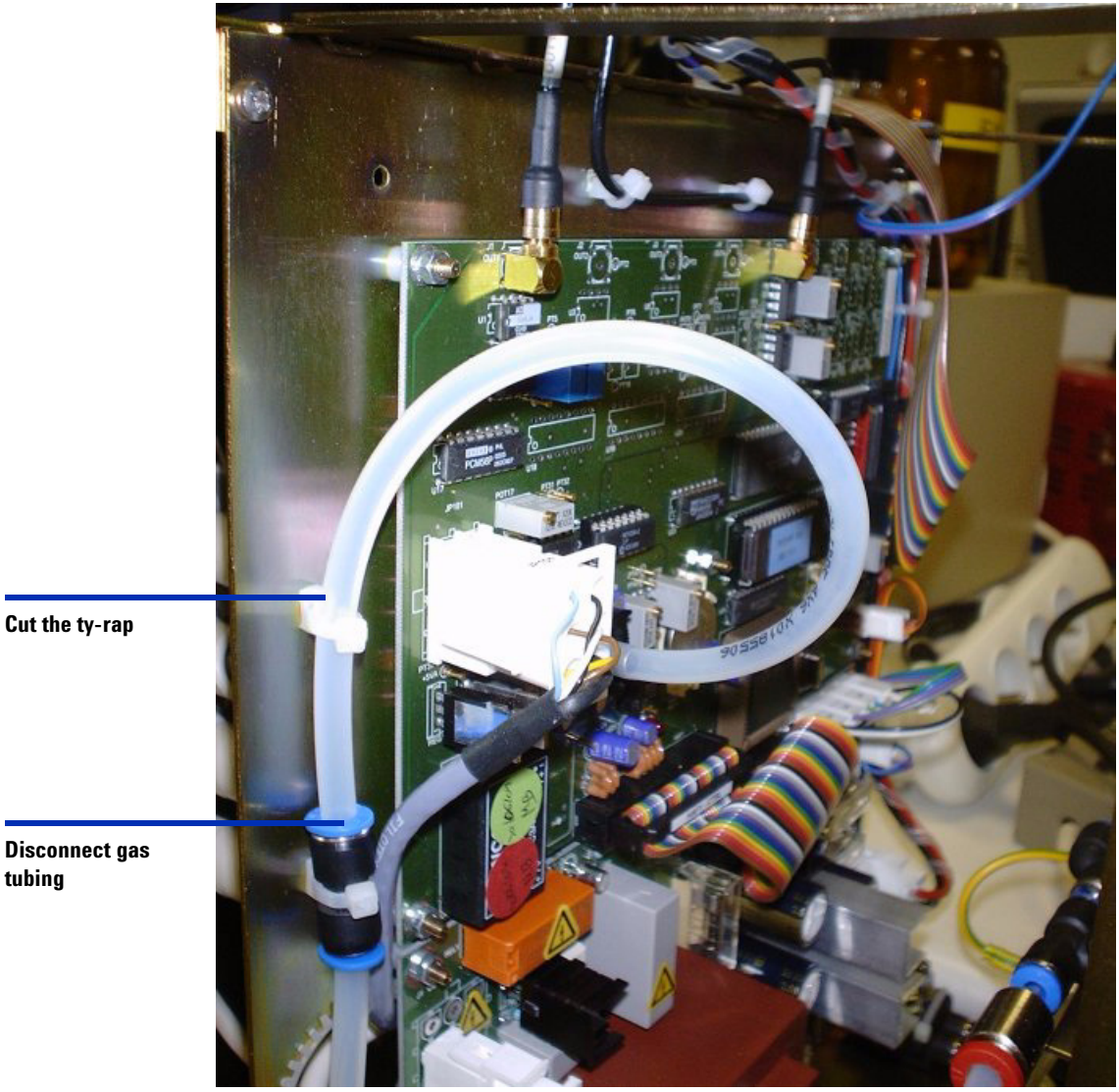



**Figure 40** Control board

**3** Remove nuts and washers which are marked red in Figure 41.
For convenience, it is suggested to use a flexible tool to remove nuts.

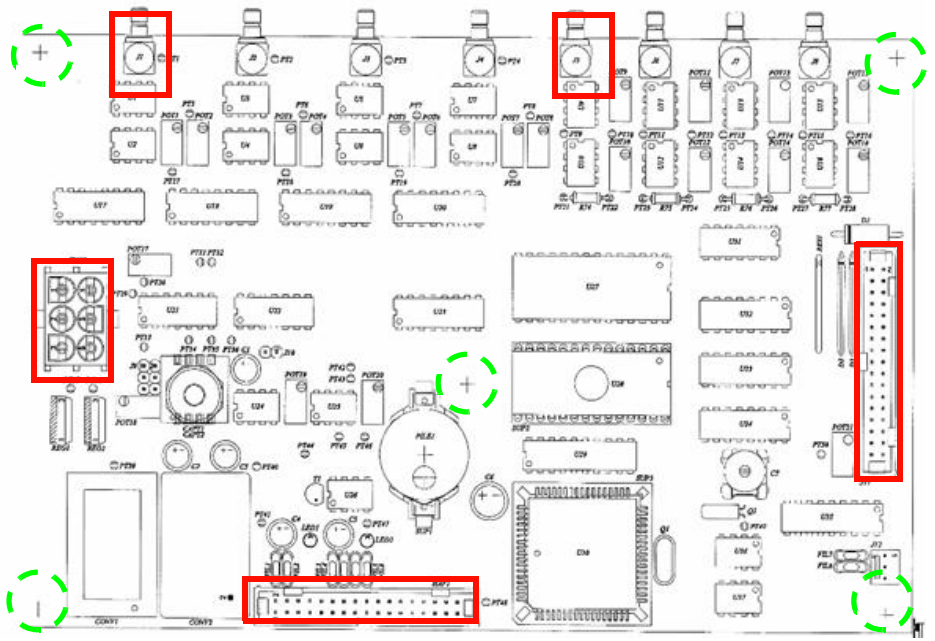


**Figure 41** Control board, detail

4 Remove the board and place the new one.

5 Connect all connectors and pressure sensor tubing.

6 Place the 5 nuts with washers.

7 Switch on the detector.

8 If necessary, adjust the stray light value according to section “Adjusting the stray light settings” on page 108.

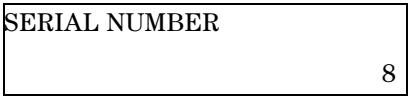
9 Switch off the detector to ensure proper internal data reinitialization.

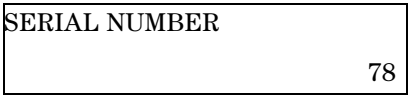
After a board replacement, the following settings need to be restored.

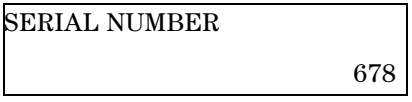
## Check internal serial number

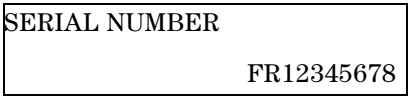
1. Enter factory menu and navigate to the "SERIAL NUMBER" menu.
2. Set the internal serial number according to the rear label, beginning by the last digit, placed at maximum right.
3. Press OK to validate.

Example:



## Set the regional voltage information

**CAUTION**

*Incorrect temperature regulation*

Wrong voltage information leads to wrong temperature regulation.

=> Make sure to type in correct voltage information.

1 Enter factory menu and navigate to the "REGIONAL VOLTAGE" menu.

| |
|---|
| Regional voltage : 100 V<br>Useful for temperature |

2 Select 100 V, 115 V or 230 V depending on your detector version.

3 Press "OK" to validate.

This ensures proper internal temperature regulation process.

## Set gain calibration values

1 Enter factory menu and navigate to the "GAIN CALIBRATION MODE" menu.

2 Set cursor on gain number and select desired gain to set with "+" and "-" buttons.

3 Using left and right arrows, select calibration value digits to be changed.

4 Proceed to the 12 gains.

Example: You want to set hexadecimal value "7ED" to gain 6.

5 Set cursor on gain with left and right arrows.

6 Press "+" or "-" to select gain 6.

| |
|---|
| Gain Calibration mode :<br>Gain : 6. Value : 6AA |

7 Press Right arrow to set cursor on first digit.

| |
|---|
| Gain Calibration mode :<br>Gain : 6. Value : 6AA |

**8** Press "+" to set digit to "7".

| |
|---|
| Gain Calibration mode :<br>Gain : 6. Value : 7AA |

**9** Press Right arrow to set cursor on second digit.

| |
|---|
| Gain Calibration mode :<br>Gain : 6. Value : 7AA |

**10** Press "+" or "-" to set second digit to "E".

| |
|---|
| Gain Calibration mode :<br>Gain : 6. Value : 7EA |

**11** Press Right arrow to set cursor on third digit.

| |
|---|
| Gain Calibration mode :<br>Gain : 6. Value : 7EA |

**12** Press "+" or "-" to set third digit to "D".

| |
|---|
| Gain Calibration mode :<br>Gain : 6. Value : 7ED |

**13** Press "OK" to validate.

**NOTE** Hexadecimal value are : 0 1 2 3 4 5 6 7 8 9 A B C D E F

## Set LED time elapsed

**NOTE** This is the number of hours the light source has been switched ON.

1 Enter the factory menu and navigate to the "LED time elapsed" menu.

```
LED time elapsed : 0 0 0 0 0
New hours : 0 0 0 0 0
```

2 The first line indicates the number of hours stored in detector, the second line indicates the number of hours you want to enter.

3 Using "+" and "-" and left and right keys, set the "New hours" elapsed according to the recorded value from the previous board.

4 Press OK to validate.

5 If this parameter is unknown when replacing the control board, the light source must be exchanged and elapsed time must be set to 0 (see “Exchanging the light source” on page 131).

## Total time elapsed

**NOTE** This is the number of hours the detector has been switched ON.

1 Enter factory menu and navigate to the "Total time elapsed" menu.

```
TOTAL time elapsed : 0 0 0 0 0
New hours : 0 0 0 0 0
```

2 The first line indicates the number of hours stored in detector, the second line indicates the number of hours you want to enter.

3 Using "+" and "-" and left and right keys, set the "New hours" elapsed according to the recorded value from the previous board.

4 Press OK to validate.

If this parameter is unknown when replacing the control board, we suggest estimating it from date of detector purchase based on 8 hours per day.

# Replacing the Power Board ALIM004

Before beginning the replacement, ensure you have the correct part for the specific regional voltage. See “Check internal serial number” on page 140.

For the following procedures, see Figure 42.

1 Unplug connectors which have been marked red in the figure.

2 Remove nuts and washers (dashed green circles).

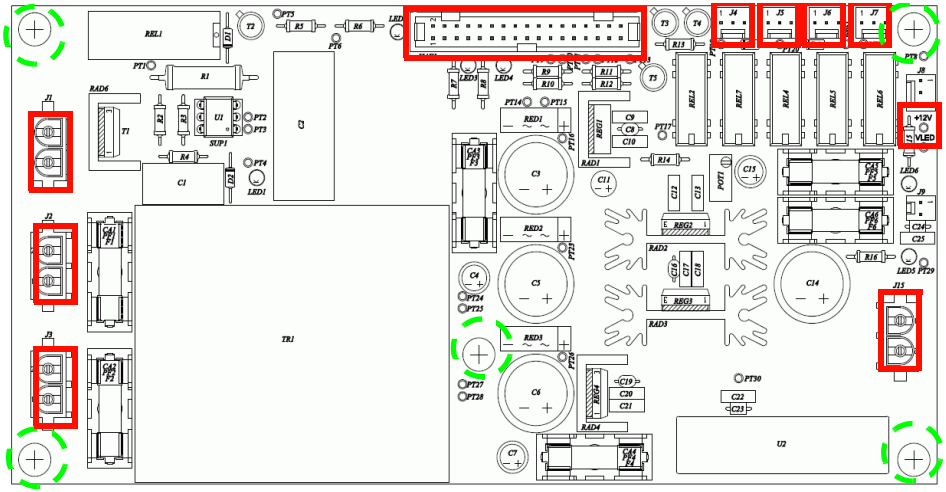


**Figure 42** ALIM004

3 Replace the board.

4 Place the 5 washers and nuts.

**CAUTION**

*Destruction of light source*

Too high voltage will destroy the light source.

=> Connect all connectors except J8 to avoid too high voltage.

=> Perform light source voltage setting according to section "Exchanging the light source" on page 131.

5 Adjust the stray light setting if necessary, see "Adjusting the stray light settings" on page 108.

**NOTE**

If the light source voltage is unknown or uncertain, it is recommended to replace the light source as the light source might get damaged otherwise causing downtime for the customer.

# Replacing the board battery

The board uses a Lithium battery CR2032 (3V), in order to retain data while the detector is switched off. When the battery needs to be replaced, replace it with a battery of the same type and make sure that it is installed using the correct polarity.

**WARNING**

***Incorrect replacement or disposal of lithium batteries.***

**Danger of explosion.**

=> Replace only with the same or equivalent type recommended by the equipment manufacturer.

=> Lithium batteries may not be disposed-off into the domestic waste. Transportation of discharged lithium batteries through carriers regulated by IATA/ICAO, ADR, RID, IMDG is not allowed. Discharged lithium batteries shall be disposed off locally according to national waste disposal regulations for batteries.

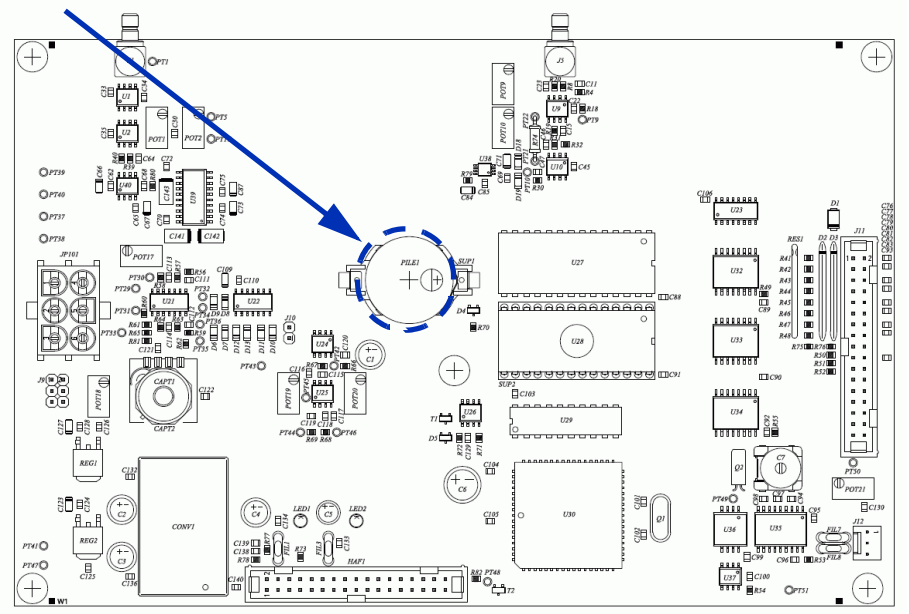


**Figure 43** Battery location

For replacing the battery :

1. Switch off the detector.
2. Unplug the main power cord.
3. Remove the detector cover for accessing the control board.
4. Remove the battery (dashed blue circles) with fingers or a non-conductive tool.
5. Place new battery in the battery holder with the + pole at the top.
6. Re-install the detector cover.
7. Plug in the main power cord.
8. Switch on the detector.
9. Set date and time “The Date/Time Screen” on page 167.
10. Switch off the detector.
11. Wait for 5 minutes.
12. Switch on the detector and check date and time.

# Upgrading firmware

Upgrading firmware consists in exchanging the memory which stores it. The EEPROM is located on CTRL005 board(see Figure 44).

The component is located on a socket for easy extraction/replacement.

**CAUTION**

*Damage of pins.*

When replacing components pins may easily be damaged.

=> Take care not to twist or damage pins while removing/reinstalling the component.

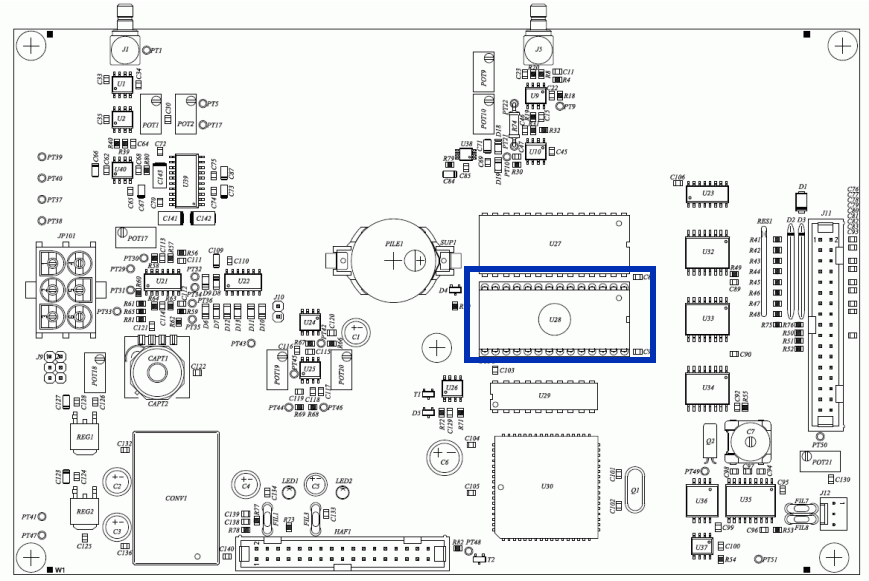


**Figure 44** Component to exchange on control board

**NOTE**

No internal data (gain calibration values, serial number etc.) will be lost during firmware upgrade because they are stored on a different chip.

# 9
# Parts for Repair

# Evaporative Light Scattering Detector Parts

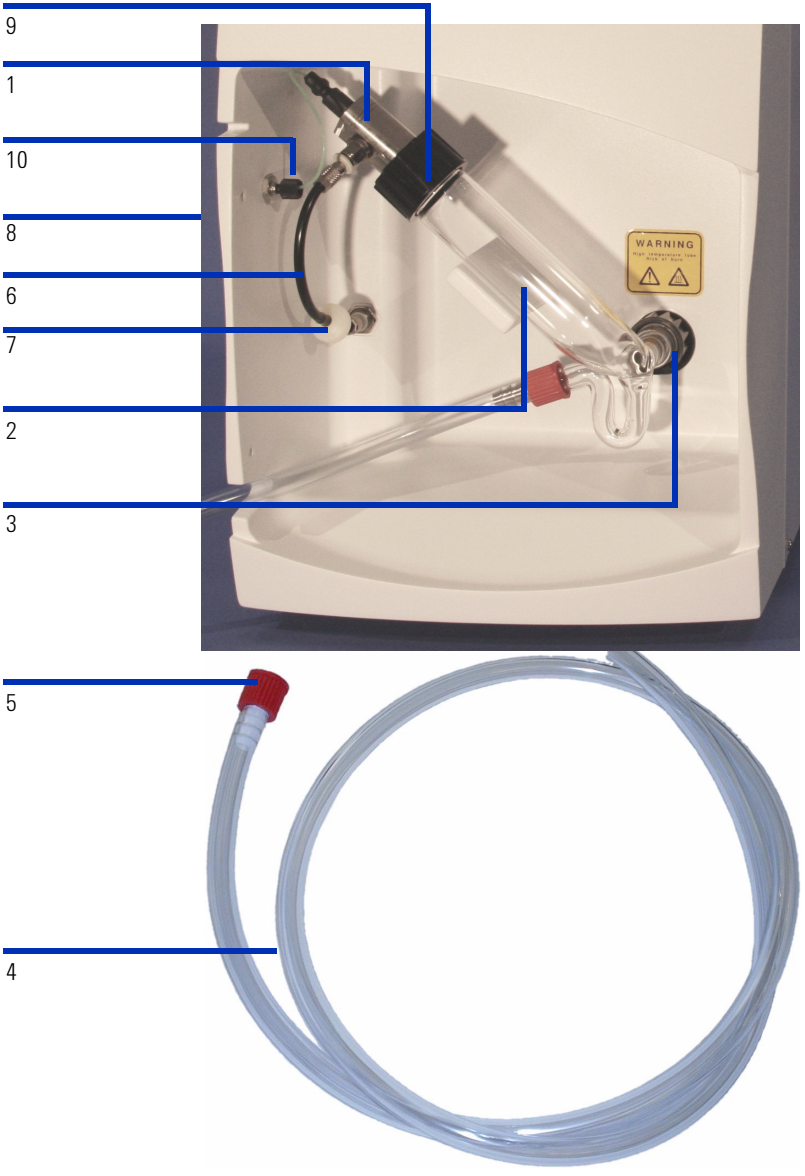



**Figure 45** Evaporative Light Scattering Detector Parts

**Table 12** Evaporative Light Scattering Detector Parts

| | Part | Part Number |
|---|---|---|
| 1 | Nebulizer Assembly | see list below |
| 2 | Nebulization Chamber (glass) | G4218-40000 |
| 3 | Black Plastic Nut for Nebulization Chamber (13 mm Diameter) | G4218-40010 |
| 9 | Black Plastic Nut for Nebulization Chamber (30 mm Diameter) | G4218-40011 |
| | Seal kit for nebulization chamber (Kit of O-rings for black nuts) | G4218-68010 |
| | Gas Regulator with Filter and Manometer | G4218-60100 |
| | Cartridge for Gas Regulator | G4218-40150 |
| 4, 5 | Drain Assembly (includes fitting) | G4218-40100 |
| | Drain Bottle Assy | G1946-60111 |
| | Black Exhaust Tube, 2.5 m | G4218-40110 |
| | ¾ inch PE Tubing for Drain Bottle, per cm | 0890-1727 |
| | Tube Fitting (6 mm diameter) for Gas Regulator | G4218-40160 |
| 6 | Pneumatic tube (diameter 4 mm) for Nebulizer (includes stainless steel fitting) | G4218-40220 |
| | Detector Gas Inlet Tube 6 mm O.D., 10 m | G4218-40170 |
| 7 | Wall Mounting Fitting (4 mm diameter) | G4218-40140 |
| 8 | Bulkhead Fitting | G4218-40130 |
| | Front panel shield window | G4218-40400 |
| | Autozero Cable | G4218-81101 |
| | Signal Cable | G4218-81100 |
| | RS 232 Cable | G4218-81103 |
| | External Event Cable | G4218-81102 |
| | Cable Remote | 5061-3378 |
| | Main Power Fuse (all voltages) | G4218-68005 |
| | Caffeine Standard 250 µg/ml in water | G4218-85000 |

**Table 13** Nebulizers for the G4218A Agilent Evaporative Light Scattering Detector

| Nebulizer | Useable Flow Range | Optimum Flow Range* | Nebulizer Back Pressure - bar (with water) | Identifying Marks | Part Number |
|---|---|---|---|---|---|
| Micro Flow Nebulizer | 5.0 µl/min – 40.0 µl/min | 15.0 µl/min – 25.0 µl/min | 24 (100 µl/min) | Blue Seal 2 Rings | G4218-20003 |
| Semi Micro Flow Nebulizer | 0.04 ml/min – 1.0 ml/min | 0.1 ml/min – 0.3 ml/min | 44 (1 ml/min) | Yellow Seal 2 Rings | G4218-20001 |
| Standard Flow Nebulizer | 0.2 ml/min – 2.0 ml/min | 0.5 ml/min – 1.2 ml/min | 4 (1 ml/min) | Black Seal 2 Rings | G4218-20000 |
| Large Flow Nebulizer | 1.0 ml/min – 5.0 ml/min | 2.0 ml/min – 3.0 ml/min | 4 (1 ml/min) | Red Seal 1 Ring | G4218-20002 |
| Rapid Resolution Nebulizer | 0.2 ml/min – 1.4 ml/min | 0.4 ml/min – 1.0 ml/min | 14†, | White Seal 1 Ring | G4218-20004 |

* The optimum flow range provides highest sensitivity and repeatability

† 14 bar at 1.4 ml/min with water/acetonitrile, 50:50)

**Table 14** Boards, electronics for the G4218A Agilent Evaporative Light Scattering Detector

| Part | Part Number |
|---|---|
| Main and power board ALIM 004 100V | G4218-65001 |
| Main and power board ALIM 004 115V | G4218-65002 |
| Main and power board ALIM 004 230V | G4218-65003 |
| Control board CTRL 005 | G4218-65020 |
| Firmware EPROM rev. 1.2 | G4218-81500 |
| Battery | G4218-81010 |
| Fan 100V | G4218-60010 |
| Fan 115V | G4218-60011 |
| Fan 230V | G4218-60012 |
| FUSE 0.5F (set of 5 fuses) | G4218-68003 |
| FUSE 2T (set of 5 fuses) | G4218-68004 |

**Table 15** Heating unit for the G4218A Agilent Evaporative Light Scattering Detector

| Part | Part Number |
|---|---|
| Heating tube stainless steel with temperature sensor 100V | G4218-60020 |
| Heating tube stainless steel with temperature sensor 115V | G4218-60021 |
| Heating tube stainless steel with temperature sensor 230V | G4218-60022 |

**Table 16** Detector unit for the G4218A Agilent Evaporative Light Scattering Detector

| Part | Part Number |
|---|---|
| Light source | G4218-81000 |
| Photomultiplier socket | G4218-81031 |
| Photomultiplier | G4218-81030 |
| Optical Head without photomultiplier (PMT) | G4218-20100 |

**Table 17** Pneumatic system for the G4218A Agilent Evaporative Light Scattering Detector

| Part | Part Number |
|---|---|
| Gas wall fitting diam 4 mm | G4218-40140 |
| Gas wall fitting diam 6 mm | G4218-40180 |
| Power down main gas valve | G4218-40210 |
| Gas check valve | G4218-40200 |
| Gas flow limiter | G4218-40190 |
| Complete internal gas tubing kit (without G4218-40210) | G4218-68020 |

**Table 18** Panels and covers for the G4218A Agilent Evaporative Light Scattering Detector

| Part | | | Part Number |
|---|---|---|---|
| Instrument cover | | | G4218-40001 |
| Front panel complete | | | G4218-60200 |
| | consisting of | Front panel without electronic | G4218-60201 |
| | | Front panel connector board | G4218-65030 |
| | | LCD screen | G4218-81200 |
| | | Keyboard | G4218-60210 |
| Detector main frame | | | G4218-00100 |
| Optical head frame | | | G4218-00110 |
| Electronic boards frame | | | G4218-00120 |
| Rear connector panel | | | G4218-00130 |
| Screw main cover, M3x10 PoziDriv(™) | | | 0515-0925 |
| Screw bottom panel, M3x6 PoziDriv(™) | | | 0515-0924 |

# 10
# The Control Panel



This chapter describes the role of the controls and the digital display on the control panel

# The Control Panel

The Control Panel (Figure 46) includes a digital display and a number of buttons that are used to enter data.


**Figure 46** The Control Panel

## The Digital Display

The digital display presents information about the present status of the detector and is used for controlling its measurement parameters. When the detector is powered up, the display will present a greetings message that includes the version number and date that the version was created for a few seconds. After the system has completed the initialization procedures, the **Status** screen (Figure 47) will be presented. The signal should be close to zero.

| Signal | Temp | Press | Gain |
|---|---|---|---|
| 001 | 26°C | 3.5b | 1 |

**Figure 47** The **Status** Screen

The user interface is provided via a series of screens, see "The User Interface" on page 160. Some screens present information about the instrument status and cannot be edited by the user (e.g. the **Status** screen), while other screens (e.g. the **Temperature/Gain** screen, Figure 49) are used to enter control parameters.

**NOTE** The control panel is disabled while the instrument is controlled externally via an RS232 connection (Chemstation etc.).

The keys on the control panel are used to provide the following functions:

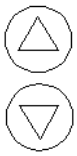
used to increase the present value of a user settable parameter (e.g. the offset) by 1 unit. If you keep the key pressed, the rate of change of the parametter will increase.

used to decrease the present value of a user settable parameter (e.g. the offset) by 1 unit. If you keep the key pressed, the rate of change of the parameter will increase.


sets the value of the parameter that you have edited.


sets the present intensity for the detector to zero.

is used to power the LED in the detector. When the LED is lit, the keyboard LED immediately above the button will be illuminated.



changes the active line on the display to the next (previous) line or the next (previous) screen.

moves the cursor on the display to the next (previous) field.

## The User Interface

The **Status** screen (Figure 47) is the default screen and is presented after initialization of the detector. In addition, it will be automatically presented again if you have accessed another screen and have not made any keystrokes within a few seconds.

Each parameter change must be validated with  or the change will not be applied.

### The Status Screen

The **Status** screen (Figure 47) displays the current measurement values of the detector. This screen cannot be edited, but the desired offset can be set via the **Offset** screen (Figure 48), the temperature and gain can be set via the **Temp/Gain** screen (Figure 49) and the pressure units can be selected via the **Noise Filter/Pressure Unit** screen (Figure 51).
The temperature value blinks if desired temperature is not reached and stable.
The pressure value blinks if the gas pressure is lower than 3.0 bar.

When the ▽ button is pressed; the **Offset** screen (Figure 48), which is used to select the desired offset is presented.

### The Offset Screen

| Signal Offset (mV) |
| --- |
| 000 |

**Figure 48** The **Offset** Screen

To increase the offset value, click on the ⊕ key. If you press the button quickly, the offset will increase by 1; if you press and hold the button, the value will increase at the rate of 20 mV/s.

Once you have set the desired offset, press the OK button to accept the new value. Please note that for user convenience, a fast offset setting can be done in the **Status** screen (Figure 47), simply by pressing the ⊕ or ⊖ key. This will change the offset value immediately.

Press the ▽ button to access the **Temp/Gain** screen (Figure 49).

### The Temperature/Gain Screen

| Temp: 50°C |
| --- |
| Gain: 1 |

**Figure 49** The **Temp/Gain** Screen

The **Temp/Gain** screen is used to set the desired Temperature and Gain. When the screen is accessed, the cursor is on the **Temp** setting. This setting can be changed with the ⊕ and ⊖ buttons and validated by the OK button. The temperature range is 20 to 100°C.

**NOTE** To maintain appropriate temperature control, the temperature should be set at least 5 °C above ambient. A wait time of 15 to 30 minutes is recommended for achieving good temperature stabilization.. The stabilization time for detector temperatures close to the ambient temperature is longer than for high temperatures.

When you press the ▽ button, the **Gain** field can be edited. The gain range is from 1-12, each increment of one unit increases the gain by a factor of 2 (e.g. if you change the gain from 1 to 4, the gain is increased by a factor of 8) and the full range of the gain is 1-2048. After setting the desired gain, press the ▽ button for navigating to the **Autozero offset** screen (Figure 50).

### The Autozero offset Screen

| Output Signal Value |
| --- |
| After AZ : *xxx* mV |

**Figure 50** The **Autozero offset** Screen

This screen is used to allow the signal to reach the desired value when performing an autozero (by keyboard, software control or external contact closure).

This function can be helpful when the user wishes to have a positive signal value instead of zero, especially with some acquisition systems which have only positive signal acquisition capability.

This setting can be changed with the ⊕ and ⊖ buttons and validated by the OK button.

After you have set the desired autozero offset, press the ▽ button for navigating to the **Noise Filter/Pressure Unit** screen (Figure 51).

### The Noise Filter/Pressure Unit Screen

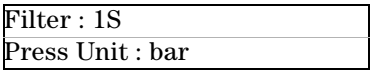



**Figure 51** The **Noise Filter/Pressure Unit** Screen

The **Filter/Pressure Unit** screen displays the settings for digital filtering of the signal data and the selected measurement unit (bar, kPa or psi) for the pressure display.

When the screen is displayed, the cursor is on the **Filter** field. By pressing ⊕ or ⊖ keys, you change the filtering strength within the following range :

- "NO" : no filtering.
- 0.5S : 0,5 second moving average filtering.
- 1S...10S : 1 to 10 seconds moving average filtering.

**NOTE**

For better results, the digital filter should be used unless the peak(s) of interest are very poorly resolved (e.g. when Rs<1.5).
Default value is 1S, corresponding to a peak width of approximately 2 seconds at half-height. See "Optimizing the Filter" on page 66 for details on filter optimization.

If you have changed the value, press OK to validate it before you press the ▽ button to access the **Press Unit** line. The pressure unit line allows for the selection of bar, kPa or psi for pressure units, the desired selection is made via the ⊕ or ⊖ key, and validated by the OK key.

When you press the ▽ button, the **LED** screen (Figure 52) will be shown.

### The LED Screen

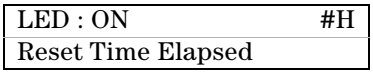



**Figure 52** **LED** Screen

The **LED** screen is used to turn the light source on/off and is equivalent to the **Light source** button on the control panel. Use the ⊕ button followed by the ⊕ button to turn the LED on and the ⊖ button followed by the OK button to turn it off.

The **# hours** field indicates the number of hours that the LED has been in use. The lifetime of the LED is approximately 5000 h. When this period has been reached, a message will be displayed after powering up the unit, that the maximum usage of the lamp has been exceeded. To reset the field, move the cursor to the **Reset Time Elapsed** field and validate by pressing OK .

**NOTE** The Reset Time Elapsed field should be validated with OK only when you change the lamp.

When you press the ▽ button, the **Light source Normalization** screen (Figure 53) will be presented.

### The Light source Normalization Screen

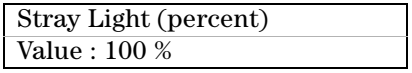



**Figure 53** The **Light Source Normalization** Screen

The intensity of the light source and consequently the measured signals will decrease over time. After replacing the light source, the signal intensity may also change.

In case your application requires to have constant signal intensities, this option can be used for adjusting the level of the signal intensity. Use either stray light measurements (see "Background Noise (Stray Light) Test" on page 76) or peak areas measured under defined conditions for doing this adjustment.

Example: Your reference measurement gave a stray light value of 120 mV. Your actual stray light measurement gives a value of 140 mV. To re-adjust the Stray Light, use the **Light Source Normalization** screen and enter a value of 85% (120/140*100), using the ⊕ and ⊖ buttons then validate by pressing OK. This will result in the stray light re-adjustment.

**NOTE** Adjustable range is from 70% to 130%. If the calculated percentage is out of this range, please contact your Agilent service representative.

When you press the ▽ button, the **Gas Valve** screen (Figure 54) will be presented.

### The Gas Valve Screen

| |
|---|
| Gas Valve: Open |
| Prog Time 0 mm Off |

**Figure 54** The **Gas Valve** Screen

The **Gas Valve** screen is used to open/close the gas valve and to setup a program to close the gas valve after a user selected time period. To use this feature, move the cursor to the time field, indicate the appropriate time, then move the cursor to **Off** and use the ⊕ or ⊖ key to select On and press OK.

When you press the ▽ button, the **External Shutdown** screen (Figure 55) will be presented.

### The Power Down Screen

The **Power Down Mode** screen (Figure 55) is used to indicate which features should be shut down upon receipt of a power down signal from an external source (e.g. a personal computer or an HPLC pump) or from the menu.

| Power down Mode: General |
| --- |
| Activate ? |

**Figure 55** The **Power Down** Screen

The three options provided for external shutdown are summarized in Table 19.

**Table 19** **Power Down** Options

| Mode | Photomultiplier | LED | Heating | Gas flow |
| --- | --- | --- | --- | --- |
| General | Off | Off | Off | Off |
| Standby | Off | Off | On | Off |
| Cleaning | Off | Off | On | On |

To select the desired **Power Down** mode, use the ⊕ or ⊖ key to access the desired mode and then press OK to validate the selection.

**NOTE** It will take a few minutes to attain operating status from *General* power down mode, as the temperature must stabilize.

Once the **Power Down** mode has been chosen and validated, the detector can be powered down in two ways:

- **External event cable power down contact closure**: The detector will stay in the power down mode chosen while the contact remains closed. It comes back in normal mode when the contact closure is released.
- **Power down screen**: Press the ▽ button to access the power down screen, then press again the ▽ button to place the cursor on the **Power down activate** line. Validate with OK to put the detector in power down mode.

**NOTE** To leave the power down mode, release the contact closure if power down has been activated by external event or press any key if power down has been activated from the **Power down** screen.

When the cursor is on the **Power down activate** line, pressing the ▽ button will present the **Date/Time** screen (Figure 56) will be presented.

### The Date/Time Screen

| |
|---|
| Date: 01/05/04 |
| Time: 14:33:21 |

**Figure 56** The **Date Time** Screen

The Date format is MM/DD/YY and the cursor will be in the day field when the screen is accessed. The day can be changed via the △ or ▽ key and the next/previous field can be accessed via the ▷ / ◁ key. Press to validate any changes.

When you press the ▽ button, the Total Lifetime Elapsed screen (Figure 57) will be presented.

### The Total Lifetime Elapsed Screen

| |
|---|
| Total Lifetime Elapsed |
| ######## hrs |

**Figure 57** The **Total Lifetime Elapsed** Screen

The **Total Lifetime Elapsed** information screen indicates the usage of the detector and cannot be edited. When you press the ▽ button, the **Serial Number** screen (Figure 58) will be presented.

### The Serial Number Screen

| |
|---|
| Serial Number |
| 0380001A |

**Figure 58** The **Serial Number** Screen

The **Serial Number** screen cannot be edited. When you press the ▽ button, the **Firmware** screen (Figure 59) will be presented.

### The Firmware Screen

| | |
|---|---|
| Firmware Version : | 2.1 |
| Firmware Date : | MM/YY |

**Figure 59** The **Firmware** Screen

This information screen (for detector firmware 2.0 and higher only) presents the firmware version and date, where MM is the month, and YY the year. The Firmware screen cannot be edited.

When you press the ▽ button, the **Factory Method Code** screen (Figure 60) will be presented.

### The Factory Method Code Screen

| |
|---|
| Factory Method Code _____ |
| Authorized persons only |

**Figure 60** The **Factory Method Code** Screen

The **Factory Method Code** screen is used by the service engineer to access procedures required for the instrument service.

# 11
# Appendix

# Safety Information

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

### General

This is a Safety Class I instrument (provided with terminal for protective earthing) and has been manufactured and tested according to international safety standards.

The Agilent 1200 Series modules are designed and certified as a general purpose laboratory instrument for research and routine application only. It is not certified for in-vitro or medical applications.

### Operation

Before applying power, comply with the installation section. Additionally the following must be observed.

Before the instrument is switched on, all protective earth terminals, extension cords, auto-transformers, and devices connected to it must be connected to a protective earth via a ground socket. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in serious personal injury. Whenever it is likely that the protection has been impaired, the instrument must be made inoperative and be secured against any intended operation.

The operator of this instrument is advised that if the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired.

Maintain a well ventilated laboratory. If the mobile phase or sample contains volatile substances, ensure that the laboratory is ventilated well such that no flammable or nocious vapors can accumulate.

Do not operate the instrument in the presence of flammable gases or fumes.Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

The exhaust from the detector must be vented into a fume hood, exhaust line or similar installation. Make sure that the exhaust gas does not escape into the laboratory. Take in consideration any solvent filter that could be required by your local environmental laws.

Potential leakage of hazardous liquids: Make sure all flow connections to and inside the detector are tight. After switching on the LC pump, verify that there are no leaks.

Use only inert gases (nitrogen) for nebulizing the mobile phase and samples. Avoid air, oxygen or reactive or inflammable gases in order to avoid the risk of burnings or explosions.

Do not use solvents, which could inflame at temperatures reached by the detector.

Avoid open flames and sparks. Do not use an open flame and do not use any equipment that can cause sparks in the same room as the instrument.

The siphon overflow tube must contain liquid at all times.

When working with solvents please observe appropriate safety procedures (e.g. goggles, safety gloves and protective clothing) as described in the material handling and safety data sheet by the solvent vendor, especially when toxic or hazardous solvents are used.

The gas pressure should not exceed 4.5 bar (67 psi). Make sure that the gas flow is maintained while the mobile phase flows through the system. If the gas flow is interrupted for extended periods of time, organic solvents could possibly damage the pressure sensor and/or the photosensor.

### Repair

Do not open the cover of the rear part of this instrument. Access to and repair of internal parts is restricted to Agilent service and service providers authorized by Agilent and certified for this instrument. For internal parts, even if the instrument is grounded, there is a potential shock hazard that could result in serious personal injury.

Make sure that only fuses with the required rated current and of the specified type (normal blow, time delay, and so on) are used for replacement. The use of repaired fuses and the short-circuiting of fuse holders must be avoided.

Do not install substitute parts or make any unauthorized modification to the instrument.

Do not disassemble the nebulizer or touch any components inside the nebulization chamber. This can lead to the deposition of contaminants which could affect the signal.

### Safety Symbols

Table 20 shows safety symbols on the instrument:

**Table 20** Safety Symbols

| Symbol | Description |
|---|---|
|  | Hot surface. Risk of burn. |
|  | Indicates dangerious voltages and electric shock hazard |
|  | The apparatus is marked with this symbol when the user should refer to the instruction manual in order to prevent risk of harm to the operator and to protect the apparatus against damage. |

**WARNING** ***A warning alerts you to situations that could cause physical injury or damage to the equipment.***

=> Do not proceed beyond a warning until you have fully understood and met the indicated conditions.

**CAUTION** *A caution alerts you to situations that could cause a possible loss of data.*

⇒ Do not proceed beyond a caution until you have fully understood and met the indicated conditions.

# Solvent Information

Observe the following recommendations on the use of solvents.

### Solvents

Brown glass ware can avoid growth of algae. Always filter solvents, small particles can permanently block the capillaries. Avoid the use of the following steel-corrosive solvents:

- Solutions of alkali halides and their respective acids (for example, lithium iodide, potassium chloride, and so on).
- High concentrations of inorganic acids like nitric acid, sulfuric acid especially at higher temperatures (replace, if your chromatography method allows, by phosphoric acid or phosphate buffer which are less corrosive against stainless steel).
- Halogenated solvents or mixtures which form radicals and/or acids, for example:

  $2CHCl_3 + O_2 \rightarrow 2COCl_2 + 2HCl$

  This reaction, in which stainless steel probably acts as a catalyst, occurs quickly with dried chloroform if the drying process removes the stabilizing alcohol.
- Chromatographic grade ethers, which can contain peroxides (for example, THF, dioxane, di-isopropylether) such ethers should be filtered through dry aluminium oxide which adsorbs the peroxides.
- Solutions of organic acids (acetic acid, formic acid, and so on) in organic solvents. For example, a 1-% solution of acetic acid in methanol will attack steel.
- Solutions containing strong complexing agents (for example, EDTA, ethylene diamine tetra-acetic acid).
- Mixtures of carbon tetrachloride with 2-propanol or THF.

# The Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC)

## Abstract

The Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC), adopted by EU Commission on 13 February 2003, is introducing producer responsibility on all Electric and Electronic appliances from 13 August 2005.

**NOTE**

This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category:

With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a “Monitoring and Control instrumentation” product.

*Do not dispose off in domestic household waste!*

To return unwanted products, contact your local Agilent office, or see www.agilent.com for more information.

# Lithium Batteries Information

**WARNING**

**Incorrect replacement or disposal of lithium batteries.**

**Danger of explosion.**

=> Replace only with the same or equivalent type recommended by the equipment manufacturer.

=> Lithium batteries may not be disposed-off into the domestic waste. Transportation of discharged lithium batteries through carriers regulated by IATA/ICAO, ADR, RID, IMDG is not allowed. Discharged lithium batteries shall be disposed off locally according to national waste disposal regulations for batteries.

---

**WARNING**

**Lithiumbatteri - Eksplosionsfare ved fejlagtig håndtering.**

**Udskiftning må kun ske med batteri af samme fabrikat og type.**

=> Lever det brugte batteri tilbage til leverandøren.

---

**WARNING**

**Lithiumbatteri - Eksplosionsfare.**

**Ved udskiftning benyttes kun batteri som anbefalt av apparatfabrikanten.**

=> Brukt batteri returneres appararleverandoren.

---

**NOTE**

Bij dit apparaat zijn batterijen geleverd. Wanneer deze leeg zijn, moet u ze niet weggooien maar inleveren als KCA.

# Agilent Technologies on Internet

For the latest information on products and services visit our worldwide web site on the Internet at:

http://www.agilent.com

Select **Products > Chemical Analysis**

It will provide also the latest firmware of the Agilent 1200 Series modules for download.

# 11 Appendix

## Agilent Technologies on Internet

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## T



## U



## V



## Z

www.agilent.com

## In This Book

This manual contains service information about the G4218A Agilent Evaporative Light Scattering Detector.

The manual describes the following:

- introduction to the detector,
- site requirements ans specifications,
- installing the detector,
- configuring the detector,
- using the detector,
- optimizing performance,
- troubleshooting and diagnostics,
- maintenance,
- repairing the detector,
- parts and materials,
- cable overview,
- the control panel,
- safety information



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